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THESIS

**AN ANALYSIS OF THE EFFECT OF COMMISSIONING
SOURCES ON RETENTION AND PROMOTION OF U.S.
ARMY OFFICERS**

by

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June 2004

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ABSTRACT

This thesis analyzes the effects of commissioning sources on the retention and promotion of U.S. Army officers.

The data in this thesis were taken from the Active Duty Military Master File, with separate data sets for cohorts commissioned from 1981 through 2001. We describe three logistic regression models: Retention to the Grade of O-4, Promotion to O-4, and Promotion to O-5.

We conclude that Academy graduates have the lowest retention rates, whereas OCS graduates have the highest retention rates. Among male officers, retention rates are higher for ROTC graduates than for those with Direct Appointments; among female officers retention rates are higher for Direct Appointments than ROTC graduates. The Promotion to O-4 Model indicates that the effect of commissioning source is different within gender, race and marital status groups. The results of the promotion to O-5 model contrasts with those of the O-4 models. Academy graduates are more likely to be promoted to Lieutenant Colonel than those from other sources, followed by ROTC graduates and then Direct Appointments.

The effects of the Army's reduction in force ("drawdown") between 1989 and 1996 are not accounted for in this thesis as they cannot be modeled with the data at hand.

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EXECUTIVE SUMMARY

Officers in the U.S. Army are commissioned through four main sources: the U.S. Military Academy (USMA), the Reserve Officer Training Corps (ROTC), Officer Candidate School (OCS), and Direct Appointment. The duration and extent of military training is different for each commissioning source, which affects the amount of exposure to military acculturation. The primary purpose of this study was to determine the effect of commissioning sources upon the retention and promotion of officers in the U.S. Army.

The data used in this thesis were taken from the Active Duty Military Master File, which includes information about the officers commissioned from 1981 through 2001. Three different models are developed in the study: Retention to the Grade of O-4, Promotion to the Grade of O-4 and Promotion to the Grade of O-5. In addition to Commissioning Source, the analysis includes Race, Gender, Marital Status, Number of Dependents, Age, Prior Enlisted Status, Education, and DoD Primary Occupation Code as explanatory variables.

The effects of the Army's reduction in force ("drawdown") between 1989 and 1996 are not accounted for in this thesis as they cannot be modeled with the data at hand. In order to model these effects survey data on factors like motivation and perceptions of career prospects would be necessary. To the extent that the influence of the drawdown was felt differently by different groups of officers (particularly on officers from different commissioning sources), it would serve to confound the effects that are attributed to other variables in this study.

The Retention to the Grade of O-4 model includes 32,054 officers commissioned between fiscal years 1981 and 1991. Retention is defined as staying in the Army to the tenth year of service. The results of the analysis indicate that commissioning source is a determinant of retention. However, the effect of commissioning source is different for the officers in different gender groups and with different marital statuses. Academy graduates are found to have the lowest retention rates and the OCS graduates are found to have the highest retention rates. Among the male officers, ROTC graduates have higher retention rates than Direct Appointments, whereas among the female officers, Direct Appointments

have higher retention rates than ROTC graduates. The results indicate that retention rates are higher for male officers than female officers, and higher for married officers than single or no-longer-married officers.

The Promotion to the Grade of O-4 model analyzes 25,740 officers who were commissioned between fiscal years 1981 and 1989. The results of the logistic regression indicate that the effect of commissioning source on promotion probabilities is different for officers in different race, gender and marital status groups. Among the white, male and married officers who constitute the majority of the observations in the data set, promotion probabilities are the lowest for the officers commissioned through the U.S. Military Academy and the highest for the officers commissioned through Officer Candidate School. In the same group, ROTC graduates are more likely to be promoted than Direct Appointments. Married officers are found to have higher promotion probabilities than single or no-longer-married officers. Being a male seems to increase the probability of promotion to Major.

The model for promotion to the grade of O-5 includes officers commissioned from 1981 through 1983. The findings indicate that Academy graduates have the highest rates for promotion to Lieutenant Colonel followed by ROTC graduates and Direct Appointments. The model does not include OCS graduates because there are only a few officers commissioned through OCS between 1981 and 1983. Having a Master's degree, not being prior enlisted and being married seems to increase the probability of promotion to Lieutenant Colonel.

I. INTRODUCTION

A. BACKGROUND

The U.S Army has been continuously changing since the collapse of the Soviet Union and the victory of Allied Forces over the Iraqi forces in Desert Shield/Storm. There are two principal drivers for this change. The first driver is the asymmetric characteristic of warfare, which requires a permanent readiness against organized violence and terrorism around the world. Another major driver for change is the introduction of new and emerging technologies, which allows for unprecedented speed and flexibility in the Army (Bruner, 2001). Starting with General Gordon Sullivan, the Chief of Staff between 1991 and 1995, the Army began a journey of transformation to realize the capabilities it needs in the new geo-strategic environment (Mait and Grossman, 2002).

Three different visions have been pursued from the beginning of the change movement to the present: digitization, preservation and transformation. General Sullivan introduced the first vision, which was to digitize forces at different levels. As a consequence, the digitization process of many of the heavy armored forces is completed, while digitization of light infantry forces is still continuing. The phrase “soldiers are our credentials” defined the second vision which was initiated by General Dennis Reimer, the Chief of Staff between 1995 and 1999, to keep as much force structure as possible in a period of declining military spending and personnel levels. In order to address future threats, General Eric K. Shinseki, the Chief of Staff between 1999 and 2003, presented the third vision, to transform the Army into a force that would be dominant across the full spectrum of operations. (Mait and Grossman, 2002)

The common point for these three visions presented by the Chiefs of Staff of the Army between the years 1991 and 2003 is the emphasis on the role of people in the change movement. One of the changes that the U.S. Military and U.S. Army has been undergoing since the end of Desert Shield/Storm is the decrease in personnel levels commensurate with the decline in military spending. Although recruiting and retaining skilled service members has always been a priority for DoD and the Army, the drawdown

of forces makes the necessity of having high-quality people much more apparent. The decrease in the levels of personnel requires the Army to achieve more with fewer people, and to recruit and maintain highly skilled people for operating complex hardware and software. An increased demand for high-quality individuals by the private sector is also a challenge faced by the Army and DoD in general. In light of these factors, the U.S Army needs to continue its efforts to recruit individuals with analytical and technical aptitudes required for the accomplishment of the mission. (Thirtle, 2001)

People in the Army include the soldiers who are active, guard or reserve and the civilians who are retirees, veterans or families. Active-duty service members are officers and enlisted personnel. Officers in the Army are college graduates while the majority of the enlisted service members are high school graduates. Officers are the leaders of the Army and are in charge of training soldiers for various tasks. Since the decisions made by the officers impact the nation's security issues, their recruitment and retention is crucial for the Army. (Shinseki, 1999)

Officers in the U.S. Army are commissioned through four main sources: (1) the U.S. Military Academy (USMA), (2) Reserve Officer Training Course (ROTC), (3) Officer Candidate School (OCS) and (4) Direct Appointment. Previous studies on the effect of commissioning sources upon officers' career progression focused on the fact that each source has a different duration of military training before commissioning. One hypothesis stated in the prior studies is that differences arise among the officers from the main commissioning sources because of different lengths of military training and different levels of exposure to military culture.

Among the four main accession programs, the U.S. Military Academy provides the longest military training. Whereas the Academy graduates are exposed to military culture throughout their four-year undergraduate program, Direct Appointments are only exposed to 3-5 weeks of military culture before commissioning. According to the earlier studies, longer military training results in better military acculturation.

There have been several studies on the effects of commissioning sources on the performance of officers in different services. Promotion and retention have been the most commonly used measures of performance in the prior studies. Although there are several

promotion and retention models used to analyze the effect of commissioning sources for Navy and Marine Corps officers, the number of studies about Army commissioning sources is limited.

Former studies on the effects of commissioning sources yielded contradictory results. In their study about the performance of officers in different racial and gender groups, RAND researchers Hosek, Tiemeyer, Kilburn, Strong, Ducksworth and Ray (2001) analyzed race and gender differences in officer career progression. In their research, they found accession source to be statistically significant. Their promotion model indicates that Academy graduates have a higher probability of promotion than those from other sources. In his study on the effect of graduate education on the promotion to Army Lieutenant Colonel, Kabalar (2003) used logit regression and classification tree models and revealed that Military Academy and ROTC/Scholarship graduates have higher promotion probabilities than those from other sources. In his comprehensive analysis of officer accession programs and the career development of U.S. Marine Corps Officers, Ergun (2003) created five different models: Promotion to O-4, Promotion to O-5, 10 YCS Retention, TBS Performance and the Performance Index Model. His findings suggest that although USNA graduates have better fitness reports at all grades between O-1 and O-4, officers from most of the other commissioning sources have higher O-4 promotion probabilities. Most of the prior studies used multivariate regression models to categorize the explanatory variables into personal and professional traits.

B. OBJECTIVES

The purpose of this thesis is to identify the effects of commissioning sources on the career progression of U.S. Army officers.

This study will examine the effects of commissioning sources on retention to the grade of O-4, and promotion to the grades of O-4 and O-5. It is possible to use the differences in the results in the cost benefit analysis of Army commissioning programs.

The analysis will include both retention and promotion models which will yield useful information in terms of comparison of retention and promotion trends in the U.S.

Army. Analyzing O-4 and O-5 promotion models separately will be beneficial to understanding the promotion trends of the officers at different ranks better.

C. RESEARCH QUESTIONS

- Is there a difference in the rate of retention to the grade of O-4 among officers from various commissioning sources?
- Is there a difference in the rate of promotion to the grades of O-4 and O-5 among officers from various commissioning sources?

D. SCOPE, LIMITATIONS AND ASSUMPTIONS

The thesis will include an overview of commissioning sources and the promotion system in the U.S. Army. Data sets used in the analysis are taken from the Active Duty Military Master File. The data file includes information about the cohorts of officers commissioned between fiscal years 1981 and 2001.

The study will develop three models: Retention to the Grade of O-4, Promotion to the Grade of O-4 and Promotion to the Grade of O-5. The analysis of retention to the grade of O-4 model uses FY 1981-1991 cohort data. Promotion to the grade of O-4 model includes officers commissioned from 1981 to 1989 and promotion to the grade of O-5 model includes officers commissioned from 1981 to 1983.

The analysis does not distinguish between ROTC Scholarship and Non-Scholarship programs. Since there are several Basic Schools for Army officers depending on their military branches, success at the Officer Basic School (OBC) will not be analyzed in the study. Factors such as evaluation reports, physical training records and awards will not be used in the study because they are not present in the data set. (Kabalar, 2003)

The effects of the Army's reduction in force ("drawdown") between 1989 and 1996 are not accounted for in this thesis as they cannot be modeled with the data at hand. In order to model these effects survey data on factors like motivation and perceptions of career prospects would be necessary. To the extent that the influence of the drawdown was felt differently by different groups of officers (particularly on officers from different commissioning sources), it would serve to confound the effects that are attributed to other variables in this study.

E. COURSE OF THE STUDY

This thesis is comprised of five chapters. Chapter II presents an overview of the pertinent literature and prior studies regarding the effects of commissioning sources on the career progression of Army officers. Chapter III addresses the data set, variable descriptions and the preliminary analysis. Chapter IV consists of multivariate analyses of retention and promotion models. Chapter V provides conclusions of the analyses and presents future research recommendations.

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II. LITERATURE REVIEW

A. COMMISSIONING OF ARMY OFFICERS

An officer is a leader in the Army in charge of planning and executing training and military operations. A commissioned officer holds the rank of Second Lieutenant or higher. Officers receive commissions upon completion of pre-commissioning requirements (Army Recruitment Web Site, Information on the Becoming an Officer, January 2004). There are two distinct types of commissions: regular and reserve. Officers who have regular commissions serve on full-time active duty under the Army's regular components, while reserve officers serve on either full-time active duty or as a part-time member of the Army's reserve components. There are four major accession programs for U.S Army officers: the U.S Military Academy, Reserve Officer Training Corps, Officer Candidate School and Direct Appointments. Although the accession sources differ in length, mission and history, they all require candidates to obtain a college degree before or shortly after becoming officers. The commissioning programs are described in the following subsections. (Thirtle, 2001)

1. The United States Military Academy (USMA)

The U.S Military Academy, better known as West Point, was founded in 1802. For two centuries, West Point has been a critical commissioning source for U.S Army officers. West Point offers a four-year undergraduate program, which provides the students development in four critical areas: intellectual, physical, military, and moral-ethical. After completing core courses in arts and sciences, cadets choose classes according to their fields of study or optional majors. Upon graduation from the Academy, all cadets receive a Bachelor of Science degree.

The Physical Program comprises both physical education classes and competitive sports. The military program, most of which happens during the summers after the end of the academic year, aims to teach the cadets basic military and leadership skills. Moral-ethical development is captured by the Academy's motto of "Duty, Honor, Country." Throughout the four-year undergraduate education, formal instructions and voluntary activities address moral and ethical issues.

Approximately 25 percent of new Lieutenants commissioned each year are Academy graduates. Being a West Point graduate is considered prestigious which makes admissions to the Academy highly selective. The basic requirements for admissions are being a United States citizen, being at least 17 years old but not yet 23 years old, being single, and not having a legal obligation to support a child. Candidates who meet the basic requirements must be qualified academically (high school record and SAT or ACT scores), mentally and physically. Admission also requires a nomination from a member of Congress or from the Department of the Army. Education at West Point is fully funded. The U.S Military Academy provides instruction, board and medical care at no costs to its students. Cadets receive an annual stipend of more than \$6,500 to offset the cost of books, uniforms and living incidentals.

Academy graduates are required to serve a total of eight years, including a minimum of five years of active duty and three years in Reserve components. The cost of an Academy graduate is about \$225,000 to the government. Over the last 200 years, West Point has prepared its graduates to serve their country as commissioned leaders in the Army. (The United States Military Academy Web Site, January 2004)

2. Reserve Officer Training Corps (ROTC)

ROTC programs were established to supplement the service academies in producing leaders for the military. The origin of ROTC programs dates back to the Land Grant Act of 1862, which required all colleges to offer military training as a payback for the land grants they received from the federal government. The National Defense Act of 1916 established the ROTC program and the ROTC Vitalization Act of 1964 made the ROTC program voluntary for all colleges. Today, more than 600 colleges and universities throughout the United States offer ROTC to educate and train future military leaders. (Thirtle, 2001)

Army ROTC is an elective curriculum attached to formal college education. ROTC students participate in a sequence of military training and leadership classes while they continue to take regular classes as a part of their undergraduate education. After graduation, they become Officers in the Army.

ROTC is comprised of two courses: Basic and Advanced. The Basic Course takes place in the first two years of a four-year academic program at a college. Students who enroll in the Basic Course take one elective class each semester. Completion of the Basic Course is a prerequisite for the Advanced Course without any military commitment. The Advanced Course coincides with the last two years of undergraduate education. Students in the Advanced Course take one elective class each semester and also attend a four-week summer camp between the junior and senior years. Entering the Advanced Course incurs a commitment to the Army. After graduation, ROTC students are commissioned in the Regular Army, Army Reserve or Army National guard.

There are both scholarship and non-scholarship ROTC programs. Scholarships are offered for two, three or four years depending on the number of years a cadet is in the program. Scholarships cover tuition and education fees but not room and board. All scholarship students receive a monthly stipend, while non-scholarship cadets receive a monthly stipend only after they enroll in the advanced course. Whether a cadet is receiving a scholarship or not affects the commitment after graduation. The Active Duty requirement for ROTC students is three years for two- and three-year scholarship holders. A four-year scholarship program adds another year to the three-year commitment. After graduation, selected ROTC cadets may choose to serve in the Army Reserve or Army National Guard to fulfill their commitment. (ARMY ROTC Web Site, January 2004)

3. Officer Candidate School (OCS)

Officer Candidate School is located at Ft. Benning, Georgia and managed by the Army Infantry School. Officer candidates are trained in basic military and leadership skills for 14 weeks. After graduation, the commission for OCS graduates is Second Lieutenants with assignment to one of sixteen basic military branches.

Officer candidates are required to have at least a 4-year college degree in order to enter OCS. Other requirements include minimum height, weight, physical and medical standards. Officer candidates are exposed to 14-weeks of military training at OCS. Candidates are required to pass physical, academic and leadership tests given at different phases of the program.

OCS is shorter in length than West Point and ROTC. It is also more flexible for commissioning officers in a shorter amount of time. OCS allows the Army to respond rapidly to the Army's personnel procurement needs. The active duty requirement for OCS graduates is four years. (Army Recruitment Web Site, Information on the Officer Candidate Program, January 2004)

4. Direct Appointment

Degreed professionals who are in the legal, medical or religious fields receive a direct commission when they join the Army. Direct appointments are exposed to three to five weeks of military training. Most direct appointments enter the Army at a higher rank than the graduates from other commissioning sources. Entering rank depends on the needs of the Army and the educational background and experience of the personnel. (Thirtle, 2001)

Training for direct appointments is comprised of leadership, military history and career-specific courses and allows candidates to implement their civilian skills in the Army. Direct appointments constitute a small portion of the commissioned officers. (Army Recruitment Web Site, Information on the Direct Commissioned Officers, January 2004)

B. OFFICER CAREER DEVELOPMENT

Department of the Army Pamphlet 600-3 "Commissioned Officer Development and Career Management" was published in 1998 to outline the officer career development and management in the U.S. Army. Officer development through the rank of Colonel is categorized into four stages in the pamphlet: Company grade development, Major development, Lieutenant Colonel Development and finally Colonel Development. Figure 2.1 shows the life cycle of officer career development.

1. Company Grade Development

This phase starts with the successful completion of pre-commissioning requirements and lasts to the twelfth year in service. Officers are required to prove qualification in their branches in the first eight years of service. Different options become available for the officers between the eighth and twelfth year of service after qualification in branches.

Officers who are commissioned through one of the four commissioning sources attend Officer Basic School (OBC) after commissioning. Officers are exposed to different lengths of military training depending on their military branches. Training includes leadership skills, equipment and personnel management, tactics and physical education. Following OBC, officers are assigned to different bases throughout the nation and overseas. Initial assignments aim to develop the small unit leadership skills of junior officers.

The second major branch school officers attend is the Captains' Career Course. Officers who are promoted to the grade of O-3 attend the Captains' Career Course to be further trained in branch-specific technical and tactical subjects. The Captains' Career Course is comprised of two phases: the branch phase and the staff process phase. The first phase is 18 weeks long and trains Captains for leadership and command at company and battery levels. The second phase is 6 weeks long and focuses on the skills required by staff officers at the battalion, brigade and division levels. Selected Captains attend the Captains' Career Course at a branch school different from their basic branch.

After completing the Captains' Career Course, officers are assigned to different bases primarily as commanders of companies, batteries and troops. Not all Captains are selected as commanders at this level because there are fewer positions than Captains. Since command at this level demands leading and managing many personnel, all officers aiming for higher ranks in the Army are expected to seek positions as company, battery or troop commanders.

Between the fifth and sixth year of service, all officers are assigned to functional areas. Officer choices, officer background and service needs determine the functional areas. Although functional areas are designated before branch qualifications, officers are still required to complete branch qualification before training or working in their functional areas.

Upon completion of branch qualification, usually in the eighth to twelfth year of service, several options become available for officers. Branch assignments, functional area development, branch/functional area generalist assignment, advanced civil schooling, training with industry, and army acquisition corps are the main options for

officers before being promoted to Major. (Department of the Army Pamphlet 600-3, “Commissioned Officer Development and Career Management,” 1998)

2. Major Development

Officers in their tenth year of service are considered to be in the primary zone for being selected to Major. Promotion can happen below or above the zone depending on the objective selection rate, which is 80 percent.

The Major development phase starts with promotion to O-4 and lasts until promotion to O-5. Officers are generally in their 12th to 17th years of service during this phase. Designation of career fields, which is a crucial point for officers, occurs in the beginning of this phase. There are four major career fields: Operations, Information Operations, Institutional Support and Operational Support. Each career field includes functional areas of different types and career branches. Officer preference, officer experience and Army needs are taken into account in the designation of career fields. Although the majority of the officers maintain their functional area, changes in the functional areas are possible because of service needs and personal choices.

Majors attend the Command and Staff Officers Course to be prepared for the positions as Majors and Lieutenant Colonels. After completing the Command and Staff Officers Course, they are required to fulfill their branch or functional area assignments. Selected Majors are assigned to joint duty positions while the majority works in their functional areas supported by training and education. (Department of the Army Pamphlet 600-3, “Commissioned Officer Development and Career Management,” 1998)

3. Lieutenant Colonel Development

Majors in the 16th year of service are considered in the primary zone for promotion to lieutenant colonel, although promotion can occur before or after this point. The Lieutenant Colonel Development phase encompasses the 17th to 22nd years of service. Being in the service for a considerable amount of time and going thorough several education and training programs, Lieutenant Colonels are expected to contribute to the Army’s needs as senior leaders and staff officers.

In this phase, Lieutenant Colonels can be assigned to branch assignments, functional assignments, joint duty assignments or branch/functional area generalist

assignments. Selected Lieutenant Colonels serve as battalion or squadron commanders, which is a highly prestigious position. Lieutenant Colonels are also selected for senior service college, which is the final formal military educational program that aims to prepare senior officers for several positions in DoD. (Department of the Army Pamphlet 600-3, “Commissioned Officer Development and Career Management,” 1998)

4. Colonel Development

The primary promotion zone for promotion to Colonel includes officers in their 21st year of military service. Colonels are assigned to senior staff and command positions where they serve the Army with a high level of knowledge and experience. Separation, retirement or promotion to brigadier general, are three cases that conclude the Colonel Development phase. (Department of the Army Pamphlet 600-3, “Commissioned Officer Development and Career Management,” 1998)

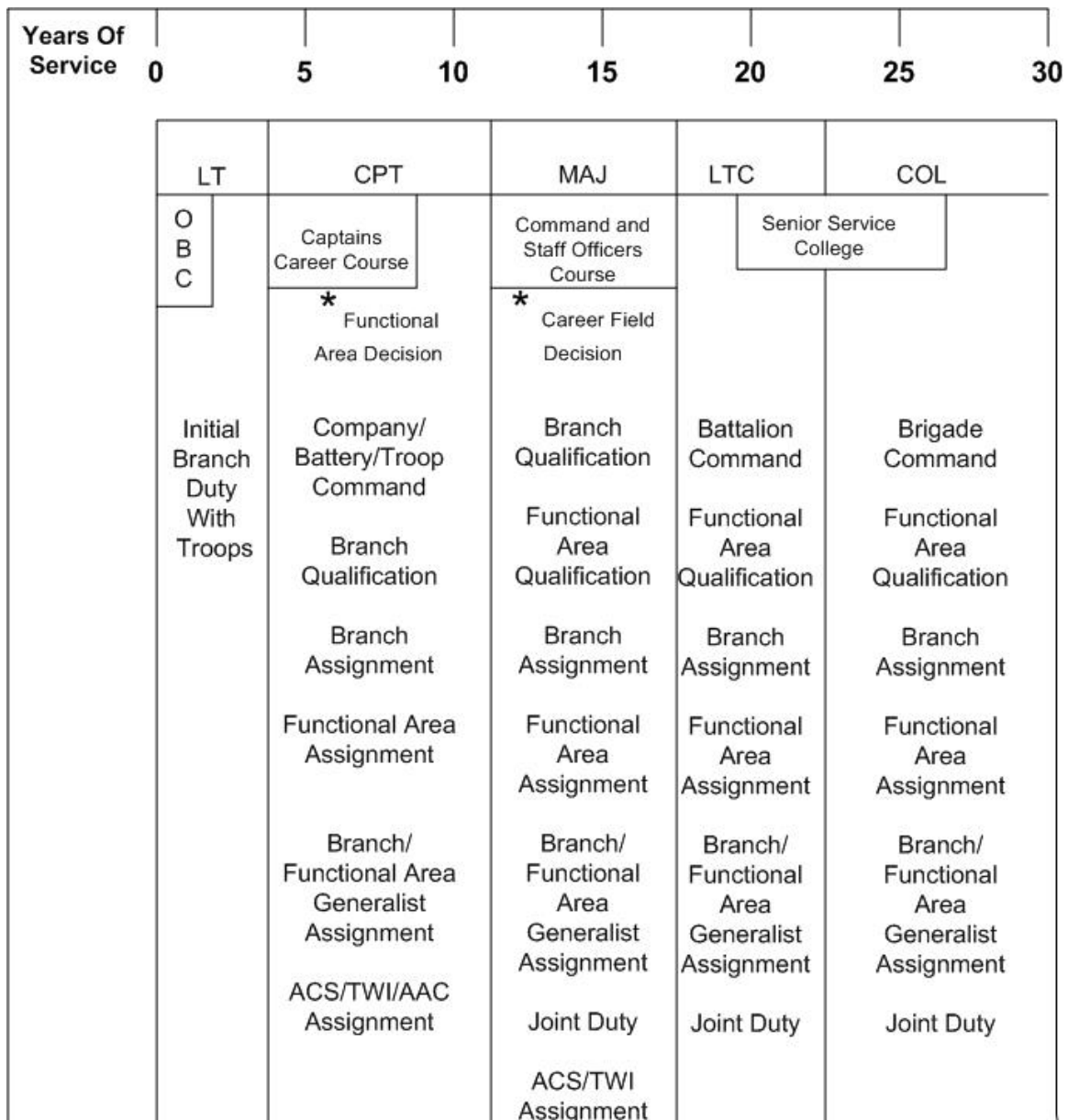


Figure 2.1. Officer Life Cycle Development Model from Department of the Army Pamphlet 600-3

C. PROMOTION SYSTEM IN THE ARMY

The promotion system in the Army pursues five major objectives stated in the Department of The Army Pamphlet 600-3 as follows:

- To ensure advancement to the higher grades of the best qualified officers;
- To meet Army branch/functional area and grade requirements;
- To provide career incentives;

- To promote officers based on the whole person concept and potential to serve in the next higher grade;
- Although not an objective, identifying and eliminating ineffective officers is another result of the promotion system. (Department of the Army Pamphlet 600-3, “Commissioned Officer Development and Career Management,” 1998)

The creation of a single Active Duty List (ADL) comprised the promotion system for commissioned officers until the introduction of career fields with The Officer Personnel Management System XXI (OPMS XXI) in 1997.

ADL included officers regardless of their components (active duty or reserve) and did not distinguish among officers with different expertise. Career field-based management is the primary change introduced with OPMS XXI. Following promotion to Major, all officers are assigned to one of the four career fields. Unlike the previous system, officers compete for promotion only with other officers in the same career fields. As a result, officers are required to satisfy only the requirements of their branch or functional area.

In both promotion systems, selection boards oversee the promotion of Army officers from Captain through Colonel. Officers in the zone of consideration are evaluated by the boards and recommended for promotion under fully or best-qualified criteria. Promotions can occur below zone, in the primary zone or above zone. Below zone is considered for officers with high performance levels whereas above zone is considered for the officers who were not selected for promotion in the primary zone. (Department of the Army Pamphlet 600-3, “Commissioned Officer Development and Career Management,” 1998)

D. PREVIOUS STUDIES

There are several studies on the effect of commissioning sources for the U.S. Navy and U.S. Marine Corps; however the number of similar studies about the U.S. Army pre-commissioning programs is limited. Promotion and retention are the most commonly used measures in the analyses of officer career progression. This chapter discusses a few of the studies regarding the impact of commissioning sources on retention and promotion of U.S. Military Personnel.

1. Study by Hosek et al. (2001)

The number of female and minority officers commissioned in the military has increased since the end of the draft in 1975. In their RAND study “Race and gender differences in career progression,” Hosek et al. (2001) investigate whether these minority and female officers are retained and promoted across the armed forces. The purpose of the research is to ascertain whether differences exist in career progression among officers in different gender and ethnic groups. Although the main point of interest was gender and ethnic differences, their study provides useful results about the effect of commissioning sources on officers’ career progression.

In their analysis, they used a data file including the records of seven cohorts: 1967, 1970, 1977, 1980, 1983, 1987 and 1991. The Defense Manpower Data Center (DMDC) prepared the data file.

Their retention model includes the grades between O-1 and O-5. Commissioning source was included in their study as an additional predictor variable. They categorized the commissioning source into five major groups: Service Academies, ROTC Scholarship, ROTC non-scholarship, OCS, and direct appointment.

Their retention model indicates that officers commissioned thorough ROTC scholarship and non-scholarship have higher retention rates compared to other commissioning sources. Lower retention rates than those from the other commissioning sources occur among academy graduates.

Their promotion model includes promotion to the grades of O-2 to O-6. For promotion, they control a three-year “promotion window” based on the fact that promotions occur below, in primary, or above zone. Their “Promotion O-3 to O-4” model reveals that, holding other factors constant, service academies have a positive effect on promotion. It was discovered that OCS and direct appointments have 10 to 15 percent lower promotion probabilities in their promotion to O-4 and promotion to O-5 models.

2. Study by Ergun (2003)

In his comprehensive thesis “An analysis of officer accession programs and the career development of U.S. Marine Corps Officers,” Ergun (2003) examined the factors

that affect career development of U.S. Marine Corps officers. His analysis includes five different models: performance at TBS, retention to 10 YCS, promotion to O-4, promotion to O-5 and evaluation of fitness reports. The goal of his study was to explain the effect of officer commissioning sources on officers' career progression.

Ergun used data from the Marine Corps Officer Accession Career (MCCOAC) data file, and Marine Corps officer fitness report data files. His analysis covers more than 28,000 Marines commissioned between FY 1980 and 1999. He used different samples for each of the five performance models. The choice of variables is also different for the five models.

In his retention model, Ergun defines "Retained_10YCS" as the dependent variable. Since 120 months is the average number of months required to be promoted to O-4, the dichotomous variable equals '1' if the number of months in the service is greater than or equal to 120 and '0' otherwise. He uses a two-stage approach in his promotion models. The first stage estimates the probabilities of survival to the promotion boards, while the second stage examines the probabilities of promotion. "Survival to promotion board" and "Promotion" are the two binary variables used for the promotion to O-4 and O-5 models.

He categorizes his independent variables into three groups: personal characteristics, cognitive human capital, and affective skills. Ergun finds that commissioning source is an important determinant of officers' career progressions. His results indicate that although USNA graduates had better fitness reports at all grades between O-1 and O-4, officers from most of the other sources had higher promotion rates to the grade of O-4. On the other hand, officers commissioned through one of the three enlisted commissioning programs had better 10-year retention rates but lower O-5 promotion rates than Naval Academy graduates. His results also indicate that officers who left were negatively correlated with average promotion probabilities.

3. Study by Kabalar (2003)

In his 2003 study "Multivariate Analysis of the Effect of Graduate Education On Promotion to Army Lieutenant Colonel," Kabalar developed logit regression and classification tree models to examine the effect of graduate education on promotion to the

rank of O-5 in the U.S. Army. There have been several studies about the effect of graduate education on the career progression of U.S. Navy and Marine Corps officers; however there have not been many studies on the promotion of Army officers. Kabalar's thesis provides an insight about the promotion system in the U.S. Army. He briefly explains the promotion system in the Army, and also, the Career-Field Based Management System.

In his study, Kabalar uses the "Active Duty Military Master File." The file includes 460 columns with both variables constant over time such as gender and time-dependent variables like age and education.

In his analysis, Kabalar defines "PROMOTED" as the dependent variable; this takes a value of '1' if the officer is selected for promotion and '0' if the officer is not chosen for promotion. He categorizes his explanatory variables into two main groups: Demographics, Professional And Educational Career Traits. Demographics consist of Gender, Age, Race, Marital Status, and Number Of Dependents. Professional and Educational Career Traits consist of Education, Commissioning Source, DoD Primary Occupation Code, and Prior Enlisted Status. Commissioning Source is assigned categorical values from 0 to 4. Commissioning source is assigned 0 if the source is unknown, 1 for the Academy graduates, 2 for the ROTC scholarship graduates, 3 for the ROTC Non-scholarship graduates, and 4 for the Direct Appointments. Officers commissioned through Officer Candidate School are not included in his analysis.

In addition to preliminary data analysis using descriptive statistics, he uses multivariate modeling analysis and classification tree analysis. Both the logit regression models and the tree models result in positive results for the effect of graduate education. While most of the explanatory variables do not seem to be statistically significant on the promotion rates, age, marital status and commissioning sources were found to be statistically significant in his analysis. His analysis indicates that Academy and ROTC Scholarship graduates have higher promotion rates than the other sources. Being married has a positive impact on promotion whereas age has a negative effect on promotion.

4. Study by Fagan (2002)

Fagan examines the determinants of performance, retention and promotion to Lieutenant Commander of naval flight officers commissioned from 1983 to 1990. Performance is defined as earning “wings of gold” after intense training. He defines retention as remaining in the service for 10 years of service. The promotion model examines officers selected for lieutenant commander.

In his training, promotion and retention models, he uses demographics (gender, race, age), commissioning source, education, training time and community platform as predictor variables. His study reveals that training time to earn wings has a considerable impact on the overall performance of naval flight officers. The promotion rates are lower for the officers who earned their wings in more time. Graduates of the United States Naval Academy (USNA) have higher success rates than NROTC and OCS graduates. The results of his retention model suggest that an undergraduate degree and ethnicity are not significant factors while marriage, gender, age and prior enlisted service are significant. The results of his promotion model indicate that NROTC graduates have the lowest probabilities of promotion. Being married increases the probability of promotion, while older ages at commissioning decreases the probability of promotion.

Previous studies on retention and promotion have found commissioning source to be a significant factor on the retention and promotion of U.S. Military officers. Table 2.1 presents a summary of the studies mentioned above. The results suggest lower retention rates for officers commissioned through the Academy. In terms of promotion probabilities for Major, prior studies suggest different conclusions for the effect of commissioning sources. Academy graduates are found to have higher promotion to Lieutenant Colonel probabilities than those from other commissioning sources.

Table 2.1. A Summary of the Previous Studies on Retention and Promotion

AUTHOR(S)	TOPIC	DATA SOURCE (S)	TECHNIQUES	FINDINGS
Hosek et al.	Race and gender differences in career progression	DMDC Cohort Data Files	Logistic regression	High retention rates for ROTC graduates, low retention rates for Academy graduates, high promotion rates for Academy graduates
Ergun (2003)	An analysis of officer accession programs and the career development of U.S. Marine Corps Officers	Marine Corps Officer Accession Career	Logistic regression	Low retention rates for Naval Academy graduates, Low promotion to Major rates for Naval Academy graduates
Kabalar (2003)	Multivariate Analysis of the Effect of Graduate Education On Promotion to Army Lieutenant Colonel	Active Duty Military Master File	Logistic regression and Classification tree analysis	High promotion to Lieutenant Colonel rates for Academy and ROTC Scholarship graduates
Fagan (2002)	Analysis of Determinants of Training, Performance, Retention, and Promotion to Lieutenant Commander of Naval Flight Officer Accession Programs and the Career Development of U.S. Marine Corps Officers	U.S. Navy Officer Master File	Logistic regression	Low promotion to Lieutenant Commander rates for Navy ROTC graduates, high promotion to Lieutenant Commander rates for Naval Academy graduates

E. CHAPTER SUMMARY

Officers in the U.S. Army are commissioned through four major accession programs, which differ in length and intensity. They start their career at the Officer Basic Schools as Second Lieutenants and go through different phases of career development. They are assigned to different tasks based on the service needs and their skills. Training is provided throughout their career in order to prepare them for different tasks.

The promotion system in the Army intends to ensure the advancement of qualified officers and to meet the service requirements. A major recent change in the promotion system is the introduction of the career field-based management system.

Previous studies on the effect of commissioning sources on the career progression of officers found conflicting results. The results suggest a lower retention probability for Academy graduates than those from other sources. In terms of promotion probabilities for Major, prior studies suggest different conclusions for the effect of commissioning sources. Academy graduates were found to have higher promotion to Lieutenant Colonel probabilities than those from other commissioning sources. Chapter III discusses the data set in the analysis.

III. DATA, MODELS AND PRELIMINARY ANALYSIS

A. DATA

The data used in this thesis were taken from the Active Duty Military Master File, which includes separate data sets for cohorts commissioned from 1981 through 2001. Each cohort data set is comprised of 460 columns (variables) and an average of 10,000 rows (observations) depending on the number of officers commissioned in that specific year. Variables represent personal demographic information, military demographic information, career timeline events, military occupation information and military test score information. Some variables represent constant information such as gender and prior enlisted status and some variables represent information such as marital status and number of dependents that is tracked yearly.

Some of the variables in the cohort data sets were irrelevant for the objectives of this study. They were discarded. Next, the relevant variables were encoded for each cohort data set. Finally, pooled retention and promotion data sets were created for descriptive and multivariate analyses.

B. VARIABLE DEFINITIONS

Retention and promotion models used in this study have dependent variables referring to retention and promotion, and include a number of independent variables representing personal characteristics and military background information. Variable selection for the models derives from the study of Kabalar (2003).

1. Dependent Variables

The dependent variable used in the retention model is a binary variable taking a value of 1 if the officer is retained 10 years after commissioning and a value of 0 if the officer is not retained 10 years after commissioning. Since pay grade information for the officers is tracked yearly in the model, it is used as a basis for identifying the value of this binary variable (RETAINED). As an example, for an officer commissioned in 1981, if the pay grade value in 1991 is blank, the dependent variable (RETAINED) is taken to be '0'. If there is a value in the pay grade column in 1991, the dependent variable (RETAINED) is taken to be '1.'

The values of the dependent variables for promotion to Major and promotion to Lieutenant Colonel are based on the pay grade information in the years officers are considered for promotion. Officers in their 10th year of service are considered to be in the primary zone for promotion to Major and officers in their 16th year of service are considered to be in the primary zone for promotion to Lieutenant Colonel (Department of the Army Pamphlet 600-3, “Commissioned Officer Development and Career Management,” 1998). However, promotion is reflected in pay grade records one year after the selection of promoted officers. An officer who is in the 10th year of service and selected for promotion to Major has a pay grade value of O-4 only in the 11th year of service. Since promotions can occur below or after the zone corresponding to the 9th and 11th year of service for promotion to Major and the 15th and 17th year of service for promotion to Lieutenant Colonel, pay grade information for three consecutive years is used in identifying the value of each binary variable (PROMOTED.O4 and PROMOTED.O5). For example, for an officer commissioned in 1981, if one of the pay grade values in years 1991, 1992 and 1993 corresponds to O-4, the dependent variable PROMOTED.O4 is taken to be ‘1’ and ‘0’ otherwise. If the same officer has a pay grade value of O-5 in 1997, 1998 or 1999, the dependent variable PROMOTED.O5 is taken to be ‘1’ and ‘0’ otherwise. Table 3.1 presents each dependent variable and its description.

Table 3.1. Dependent Variables and Descriptions

RESPONSE VARIABLES	
RETAINED	0 IF THE OFFICER HAS A BLANK PAY GRADE AT TEN YEAR MARK
	1 IF THE OFFICER HAS A PAY GRADE AT TEN YEAR MARK
PROMOTED.O4	0 IF THE OFFICER IS NOT PROMOTED TO O4
	1 IF THE OFFICER HAS IS PROMOTED TO O4
PROMOTED.O5	0 IF THE OFFICER IS NOT PROMOTED TO O5
	1 IF THE OFFICER HAS IS PROMOTED TO O5

2. Independent Variables

Independent variables are grouped into two categories based on Kabalar’s study: Demographics, and Professional and Educational Traits. Demographics include AGE, MARITAL STATUS, GENDER, RACE, and NUMBER OF DEPENDENTS. Professional factors include EDUCATION, COMMISSIONING SOURCE, DOD

PRIMARY OCCUPATION CODE (DPOG), and PRIOR ENLISTED (PE). (Kabalar, 2003)

EDUCATION, MARITAL STATUS, and NUMBER OF DEPENDENTS are variables tracked yearly in the data sets. The other six variables are constant for the officers in the data sets. All constant variables are included in the analysis of retention and promotion models in this study. However, the models handle time-dependent variables differently.

In retention to the rank of Major and promotion to the rank of Major models, for Marital Status and Number of Dependents, status at the fourth-year point was selected for two main reasons. The first reason is that promotion to Captain occurs after four years in service and status at the rank of Captain seems reasonable for retention and promotion to the rank of Major models. The second reason is that the active duty requirement for the majority of commissioned officers is four years and many separations, which correspond to empty cells in the data set, occur after the active duty requirement. An alternative approach would be to look at the status in the year of commissioning, which would cause bias because Academy graduates are not allowed to marry until graduation. Education was not used in the promotion and retention to the rank of Major models because most Army officers are selected for graduate schools only after finishing the Captains' Career Course and serving as company commanders. As a result, six constant variables and two time dependent variables (MARITALSTAT.O3 and NUMDEPEND.O3) are used as explanatory variables in the retention and promotion to the rank of Major models.

In the model for promotion to the rank of Lieutenant Colonel, status at the 10th year, which corresponds to the status at the Major selection point, was selected for time-dependent variables consistent with the first reason stated above. Education is included in the model because the data sets include a considerable number of observations with graduate education at the 10th year of service. Promotion to the rank of Lieutenant Colonel includes the six constant variables mentioned above and three time-dependent variables (MARITALSTAT.O4, NUMDEPEND.O4, and EDUCATION) (Kabalar, 2003).

In some prior studies about retention and promotion, performance measures such as performance at the Basic Schools were also included as explanatory variables. Since the data set does not include any performance measures in the career development of commissioned officers, they are not used in the analysis. Table 3.2 presents the independent variables and their descriptions.

Table 3.2. Independent Variables and Descriptions (After Kabalar, 2003)

DEMOGRAPHICS	
GENDER	1 IF MALE
	2 IF FEMALE
RACE	0 UNKNOWN
	1 IF WHITE
	2 IF AFRICAN AMERICAN
	3 IF OTHER
MARITALSTAT.O3	1 IF THE OFFICER IS SINGLE
MARITALSTAT.O4	2 IF THE OFFICER IS MARRIED
	3 IF THE OFFICER IS NO LONGER MARRIED
NUMDEPEND.O3	1 IF OFFICER ONLY AND 0 DEPENDENT
NUMDEPEND.O4	2 IF THE OFFICER AND 1 DEPENDENT
	3 IF THE OFFICER AND 2 DEPENDENTS
	4 IF THE OFFICER AND 3 DEPENDENTS
	5 IF THE OFFICER AND FOUR OR MORE DEPENDENTS
AGE	AGE AT COMMISSIONING
PROFESSIONAL AND EDUCATIONAL TRAITS	
EDUCATION	1 IF THE OFFICER HAS A BACCALAUREATE OR LOWER
	2 IF THE OFFICER HAS A MASTER'S OR HIGHER DEGREE
COMMSOURCE	1 IF THE OFFICER IS AN ACADEMY GRADUATE
	2 IF THE OFFICER IS COMMISSIONED THROUGH ROTC
	3 IF THE OFFICER IS COMMISSIONED THROUGH OCS
	4 IF THE OFFICER IS COMMISSIONED BY DIRECT APPOINTMENT
DPOG	0 IF UNKNOWN
	1 IF TACTICAL OPERATIONS OFFICER
	2 IF INTELLIGENCE OFFICER
	3 IF ENGINEERING AND MAINTENANCE OFFICER
	4 IF HEALTH CARE OFFICERS
	5 IF ADMINISTRATORS
	6 IF SUPPLY, PROCUREMENT AND ALLIED OFFICER
PE	0 IF THE OFFICER IS NOT PRIOR ELISTED
	1 IF THE OFFICER IS PRIOR ENLISTED

C. SAMPLES USED IN ANALYSIS

Officers commissioned from 1981 to 1991 were analyzed in the retention to the grade of O-4 model. Promotion to the grade of O-4 model includes officers commissioned from 1981 to 1989, while promotion to the grade of O-5 model includes officers commissioned from 1981 to 1983. At the beginning of the study, officers who have a pay grade different than O-1 at the time of commissioning were eliminated. Since the focus of the analysis is to identify the effect of commissioning sources on promotion and retention, observations with unknown commissioning sources were also eliminated. OCS graduates are not included in the model for promotion to the grade of Lieutenant Colonel because there were only a few officers commissioned through OCS between 1981 and 1983. Warrant officers and officers who switched to warrant officers were also eliminated because grade structures and promotions are different for warrant officers.

Unknown values for the explanatory variables were dealt with differently. Observations with unknown marital status, number of dependents, education level, gender and prior enlisted status were eliminated from the data set because there were not many unknown values for these variables. Since age at commissioning (AGE) was calculated by subtracting the commissioning year from the year of birth date, age for observations with unknown birth dates were assigned the mean value in each data set. Unknown values for race and DOD Primary Occupation Code (DPOG) were included in the analysis.

Officers who had not reached the rank of at least O-2 at the fourth year of service were eliminated from the promotion to the rank of Major model and officers who had not reached the rank of at least O-3 were eliminated from promotion to the Lieutenant Colonel model. Table 3.3 lists the sample sizes and retention and promotion rates for the models used in the analysis.

Table 3.3. Samples Used in the Analysis

MODEL	NUMBER OF OBSERVATIONS	RETENTION / PROMOTION RATES
RETENTION MODEL	32054	0.573
PROMOTION TO O4 MODEL	25740	0.436
PROMOTION TO O5 MODEL	4211	0.519

D. DESCRIPTIVE STATISTICS

1. Retention to the Grade of O-4 Model

The model includes 32,054 officers commissioned from fiscal years 1981 to 1991. Table 3.4 contains the number of observations, proportion in sample, number of retained officers and retention rate values for each level of variable used in the model. While Academy and ROTC graduates form 88 percent of the officers in the sample, the retention rate for officers commissioned thorough OCS is higher. The difference between retention rates for OCS graduates and Academy graduates is approximately 27 percent. The majority of the officers in the sample are married, white, male and not prior enlisted. The retention rate for married officers is higher than the retention rate for single officers. Higher retention rates for married officers and for officers with dependents may indicate a positive relationship between retention and these factors. Male officers have a higher retention rate than female officers. Prior enlisted officers only constitute about 23 percent of the data in the sample but retention rates for prior enlisted officers imply a positive relationship between retention and being prior enlisted.

Table 3.4. Descriptive Statistics for Retention

VARIABLE	LEVEL	NUMBER OF OBSERVATIONS	PROPORTION	NUMBER OF RETAINED	RETENTION RATE
COMSOURCE	Academy	8385	0.2616	3856	0.4599
	ROTC	19954	0.6225	12107	0.6067
	OCS	1438	0.0449	1057	0.7350
	Dir. App.	2277	0.0710	1332	0.5850
MARITALSTAT	Single	10867	0.3390	5675	0.5222
	Married	20285	0.6328	12150	0.5990
	No longer mar.	902	0.0281	527	0.5843
NUMBER OF DEPENDENTS	No dep.	13400	0.4180	7016	0.5236
	1 dep.	9744	0.3040	5615	0.5763
	2 dep.	5047	0.1575	3168	0.6277
	3 dep.	2862	0.0893	1905	0.6656
	4 or more dep.	1001	0.0312	648	0.6474
RACE	Unknown	1484	0.0463	804	0.5418
	White	26435	0.8247	15016	0.5680
	Black	3219	0.1004	2007	0.6235
	Other	916	0.0286	525	0.5731
GENDER	Male	27324	0.8524	16112	0.5897
	Female	4730	0.1476	2240	0.4736
DPOG (DOD Primary)	Unknown	3935	0.1228	2105	0.5349
	Operations	15924	0.4968	9208	0.5782

VARIABLE	LEVEL	NUMBER OF OBSERVATIONS	PROPORTION	NUMBER OF RETAINED	RETENTION RATE
Occupation Group)	Intelligence	1625	0.0507	965	0.5939
	Engineering	3883	0.1211	2199	0.5664
	Health care	3054	0.0953	1710	0.5599
	Administrators	1819	0.0567	1101	0.6052
	Supply	1814	0.0566	1064	0.5865
PE	No	24596	0.7673	13289	0.5402
	Yes	7458	0.2327	5063	0.6788
TOTAL	-	32054	1	18352	0.5730
AGE (MEAN)	23.9				

2. Promotion to the Grade of O-4 Model

The promotion to Major model analyzes 25,740 officers commissioned from fiscal years 1981 thorough 1989. Table 3.5 provides the number of observations and proportions in the sample for each variable used in the model. The distribution of officers across the levels of explanatory variables is similar to the retention to the grade of O-4 model. Table 3.5 presents the promotion rates for each level of explanatory variables.

Similar to the initial retention distribution presented in Table 3.4, the rate of promotion to Major for Academy graduates is the lowest among all the commissioning sources. The difference in promotion rates between OCS and Academy graduates is about 14 percent. White officers have a higher probability of promotion to Major than those who are black or of other races. Prior-enlisted officers have a 7 percent higher promotion rate than non-enlisted officers. There is not a significant difference among the officers in different Primary Occupation Code groups. Officers with no dependents and with 4 or more dependents have lower promotion rates than officers with 1, 2 or 3 dependents. Forty-four percent of all the commissioned officers in the sample were selected for promotion to Major. Initial examination of the results presented in Table 3.5 suggests dependence between commissioning source and promotion to Major of Army officers.

Table 3.5. Descriptive Statistics for Promotion to the Grade of O-4

VARIABLE	LEVEL	NUMBER OF OBSERVATIONS	PROPORTION	NUMBER OF PROMOTED	PROMOTION RATE
COMSOURCE	Academy	7042	0.2736	2657	0.3773
	ROTC	15703	0.6101	7167	0.4564
	OCS	1019	0.0396	523	0.5132
	Dir. App.	1976	0.0768	869	0.4398
MARITALSTAT	Single	8759	0.3403	3382	0.3861
	Married	16292	0.6329	7556	0.4638
	No longer mar.	689	0.0268	278	0.4035
NUMBER OF DEPENDENTS	No dep.	10788	0.4191	4235	0.3926
	1 dep.	7867	0.3056	3617	0.4598
	2 dep.	4073	0.1582	1944	0.4773
	3 dep.	2241	0.0871	1089	0.4859
	4 or more dep.	771	0.0300	331	0.4293
RACE	Unknown	1479	0.0575	608	0.4111
	White	21122	0.8206	9335	0.4420
	Black	2447	0.0951	1016	0.4152
	Other	692	0.0269	257	0.3714
GENDER	Male	21933	0.8521	9855	0.4493
	Female	3807	0.1479	1361	0.3575
DPOG (DOD Primary Occupation Group)	Unknown	3869	0.1503	1487	0.3843
	Operations	12134	0.4714	5446	0.4488
	Intelligence	1327	0.0516	598	0.4506
	Engineering	3253	0.1264	1375	0.4227
	Health care	2348	0.0912	1048	0.4463
	Administrators	1501	0.0583	708	0.4717
	Supply	1308	0.0508	554	0.4235
PE	No	20942	0.8136	8831	0.4217
	Yes	4798	0.1864	2385	0.4971
TOTAL	-	25740	1	11246	0.4360
AGE (MEAN)	23.7				

3. Promotion to the Grade of O-5 Model

4,211 officers who were commissioned from 1981 to 1983 were analyzed in the model for promotion to the rank of Lieutenant Colonel. About 52 percent of the officers were selected for promotion to O-5. The rate for promotion to Lieutenant Colonel is higher than the rate for promotion to Major. In the promotion to Major model, officers who had not reached at least the rank of O-2 at the fourth year point (Captain selection point) were eliminated from the analysis. In the promotion to Lieutenant Colonel model, officers who had not reached at least the rank of O-3 at the tenth year point (Major selection point) were eliminated from the analysis. The difference between the promotion

rates for promotion to O-4 and promotion to O-5 models implies that the proportion of separations between the Captain selection point and the Major selection point is greater than the proportion of separations between the Major selection point and the Lieutenant Colonel selection point.

Table 3.6 presents the descriptive statistics for promotion to the O-5 model. In contrast to the promotion rates listed by Table 3.5, Academy graduates have the highest promotion rates. Academy graduates have an 11 percent higher promotion rate than officers commissioned thorough ROTC and a 24 percent higher promotion rate than Direct Appointments. Similar to the initial results provided by the model for promotion to O-4, male and married officers are more likely to be promoted. Prior- enlisted officers are less likely to promote to O-5 than non-enlisted officers. White officers have a higher promotion rate than black officers but a lower promotion rate than other races.

Table 3.6. Descriptive Statistics for Promotion to the Grade of O-5

VARIABLE	LEVEL	NUMBER OF OBSERVATIONS	PROPORTION	NUMBER OF PROMOTED	PROMOTION RATE
COMSOURCE	Academy	1275	0.3027	780	0.6118
	ROTC	2445	0.5806	1223	0.5002
	Dir. App.	491	0.1167	183	0.3727
MARITALSTAT	Single	457	0.1085	202	0.4420
	Married	3568	0.8473	1915	0.5367
	No longer mar.	186	0.0442	69	0.3710
NUMBER OF DEPENDENTS	No dep.	719	0.1707	347	0.4826
	1 dep.	840	0.1994	435	0.5178
	2 dep.	872	0.2070	438	0.5022
	3 dep.	1198	0.2844	678	0.5659
	4 or more dep.	582	0.1382	288	0.4948
RACE	Unknown	731	0.1740	414	0.5663
	White	3199	0.7592	1632	0.5101
	Black	201	0.0476	95	0.4726
	Other	80	0.0192	45	0.5679
GENDER	Male	3718	0.8830	1948	0.5239
	Female	493	0.1170	238	0.4818
DPOG	Unknown	1591	0.3772	778	0.4896
	Operations	1329	0.3157	739	0.5551
	Intelligence	201	0.0478	105	0.5198
	Engineering	519	0.1234	259	0.4990
	Health care	231	0.0549	112	0.4828
	Administrators	284	0.0675	157	0.5509

VARIABLE	LEVEL	NUMBER OF OBSERVATIONS	PROPORTION	NUMBER OF PROMOTED	PROMOTION RATE
	Supply	56	0.0135	36	0.6316
PE	No	3457	0.8209	1901	0.5498
	Yes	754	0.1790	285	0.3779
EDUCATION	No grad. Educ.	2796	0.6639	1310	0.4683
	Grad. education	1415	0.3360	876	0.6180
TOTAL	-	4211	1	2186	0.5191
AGE (MEAN)	23.4				

E. CHAPTER SUMMARY

The purpose of this study is to analyze the effect of commissioning sources on the retention and promotion of officers in the U.S. Army. Data used in the thesis were obtained from the Active Duty Military Master File. Officers commissioned from 1981 to 1991 were analyzed in the retention to the grade of O-4 model, while officers commissioned from 1981 to 1989 were analyzed in the promotion to the grade of O-4 model. The model for promotion to the grade of O-5 includes officers commissioned from 1981 to 1983.

Preliminary analysis of the effect of commissioning sources on the retention and promotion models suggests dependence between the commissioning source and retention and promotion of the U.S. Army officers. Officers commissioned through the U.S. Military Academy seem to be less likely to stay until the Major selection point and less likely to be promoted to Major but more likely to receive a promotion to Lieutenant Colonel.

Chapter IV discusses the multivariate analysis for retention and promotion models.

IV. MULTIVARIATE ANALYSIS

This chapter contains the results of multivariate analyses for retention and promotion to the grade of O-4 and promotion to the grade of O-5 in the U.S. Army. First, a brief description of logistic regression and the steps of logistic regression analysis applied to retention and promotion models in this study are presented. Then, evaluation and interpretation of analysis for each model is provided in separate sections. The chapter concludes with a summary and comparison of the results found in the logistic regression models.

A. METHODOLOGY

Regression models are used to determine the relationship between a dependent (response) variable and one or more independent (explanatory or predictor) variables. Logistic regression is a special form of regression used in the presence of a binary or a dichotomous dependent variable (Hosmer and Lemeshow, 2000). Since the dependent variables used in the retention and promotion models in this study are binary, taking the values of ‘0’ or ‘1,’ logistic regression is used as a tool for analysis.

The goal of an analysis using logistic regression is the same as that of any model-building technique used in statistics: find the best fitting and most parsimonious model to describe the relationship between an outcome variable and a set of explanatory variables (Hosmer and Lemeshow, 2000). The software package S-Plus ® 6.1 was used to build and assess the models in this study using the steps explained in the following paragraphs.

The first step taken before fitting the models was managing categorical variables. A categorical variable with k levels was replaced with $k-1$ dummy (0-1) variables, with one category being chosen as the “baseline.” Categories chosen as a “baseline” for each categorical explanatory variable are:

COMMISSIONING SOURCE	Academy
MARITAL STATUS	Single
NUMBER OF DEPENDENTS	No dependent
EDUCATION	Baccalaureate or lower

DPOG	Unknown
PRIOR ENLISTED	Not prior enlisted
RACE	Unknown
GENDER	Male

The second step was fitting the models using the main effects of the independent variables. An analysis of deviance test (McCullagh and Nelder, 1989) was used to determine whether the independent variables help explain the dependent variable. The effect of each independent variable was determined by trying all one-term deletions from a model using the `dropterm()` function from S-Plus's MASS library.

Without deleting any independent variable based on the analysis of main effects, stepwise selections of variables including the interactions was performed. Having developed the models by using a stepwise algorithm, evaluation of the models was performed before interpreting the results.

Evaluation of the logistic regression models focused on three parts (Menard, 2002, p. 17). First, overall adequacy of the models was analyzed by calculating goodness-of-fit and predictive efficiency statistics. Predictive efficiency of the models was analyzed by comparing the misclassification rates of the models with the naïve estimation error rates. Goodness-of-fit statistics included analysis of deviance (McCullagh and Nelder, 1989) and the Hosmer-Lemeshow test (Hosmer and Lemeshow, 2000). In the Hosmer-Lemeshow test, predictions are sorted and divided into groups of equal size and in each group the actual proportion of “good” responses and the average of the predicted probabilities are computed. These should be close for a good model. Hosmer and Lemeshow test also provides a goodness-of-fit statistic, \hat{C} , which is obtained by calculating the Pearson chi-square statistic from observed and estimated expected frequencies. The \hat{C} test statistic, which approximately follows a chi-square distribution with $m-2$ (number of groups minus 2) degrees of freedom, is used to test the null hypothesis that states that the model fits well (Hosmer and Lemeshow, 2000, p. 148). The second part of the evaluation focused on logistic regression diagnostics. Diagnostics included analysis of residuals and detection and dealing with influential and poorly fitted

observations. A plot of change in deviance versus predicted probability was used to detect poorly fitted observations and a plot of influence statistics (ΔB) was used to detect influential observations (Hamilton, 1992, p. 238). The last part of the evaluation dealt with the contribution of each independent variable or interaction between the independent variables. Statistical significance of the coefficients was calculated by using Wald statistics. A Wald statistic is calculated as $W_j = \hat{\beta}_j / SE(\hat{\beta}_j)$, and approximately follows a standard normal distribution (Hosmer and Lemeshow, 2000, p. 37). However, interpretation of the statistical significance of coefficients was not straightforward for the models developed by stepwise selection in this study for two reasons. The first reason is the different results obtained for the significance of interaction terms. While the commissioning source was found statistically significant even at 99 percent confidence level in the retention model, its interaction with marital status yielded different results in terms of statistical significance. The second reason is the considerable amount of search done for selecting the explanatory variables used in the models. Variable selection based on searching tends to exploit chance patterns in the samples, leading to conclusions that may not apply to other samples or to the population (Hamilton, 1992, p. 83). For these reasons, a cautious interpretation of Wald statistics is warranted.

After completing the evaluation of the fitted models, interpretation of the models was performed as a final step. Interpretation focused on the effect of commissioning sources on the predicted retention and promotion probabilities. A discussion of the effects of other independent variables is also included. Since stepwise variable selection procedures used during the model development step suggested effects of interaction, interpretations of the fitted values were performed considering the interactions.

Using odds ratios is a common approach in the interpretation of logistic regression results for the categorical explanatory variables. The reason for this is the ease of calculation and interpretation. In a logistic regression model without any interactions, odds ratios are calculated simply by exponentiation of the estimated coefficients. Confidence intervals for coefficients are calculated by the expression $\exp[\hat{\beta}_i \pm Z_{(1-\alpha/2)} * SE(\hat{\beta}_i)]$ (Hosmer and Lemeshow, 2000). However, in the presence of interactions, odds ratios and confidence intervals of odds ratios should be calculated

separately considering every single category of both interaction terms. In the logistic regression models developed in this thesis, confidence intervals for odds ratios were calculated only for the main effects of the explanatory variables not interacting with any other variable. Interpretation of the results in case of interactions was done by comparing the predicted probability of the outcome variable in each category of the interacting independent variables.

B. RETENTION TO THE GRADE OF O-4 MODEL

The Retention to the grade of O-4 model analyzes the effect of explanatory variables on the retention of U.S. Army officers commissioned from 1981 to 1991. Retention is defined as staying in the Army to the ten-year mark. The model suggested by stepwise logistic regression is included in Appendix A. Table A.1 contains the estimated coefficients, standard errors, t-values, and Wald statistics p-values for each explanatory variable and interaction. Confidence intervals for the odds ratios are only presented for those main effects, which do not appear in interactions.

Using the three steps described in the Methodology section, the model presented in Table A.1 was evaluated. In order to measure the predictive efficiency of the model, a classification table was created. Officers with predicted retention probabilities greater than 0.5 were predicted as retained at the ten-year mark. Table 4.1 shows that the misclassification rate of predictions is 39 percent. Although the misclassification rate is 4 percent lower than the naïve misclassification rate, it can still be considered as quite high. However, in the retention model used in this study, high error rates were expected because of the general difficulty of prediction in the case of regression based on people.

Table 4.1. Retention to the Grade of O-4 Model Classification Table

OBSERVED VALUES	PREDICTION VALUES	
	FALSE	TRUE
0	5788	7914
1	4715	13637
Naïve Misclassification Rate	$13702/32054 = 0.43$	
Prediction Misclassification Rate	$(4715+7914) / 32054 = 0.39$	

The result of the Hosmer-Lemeshow test is provided in Table A.1. The p-value of 0.98 indicates that the null hypothesis, which states that the model fits adequately, cannot

be rejected. Comparison of the expected percentages of retained officers versus observed percentages of retained officers in each of 10 groups is shown in Figure 4.1. Figure 4.1 indicates that it is possible to use the model to predict retentions accurately.

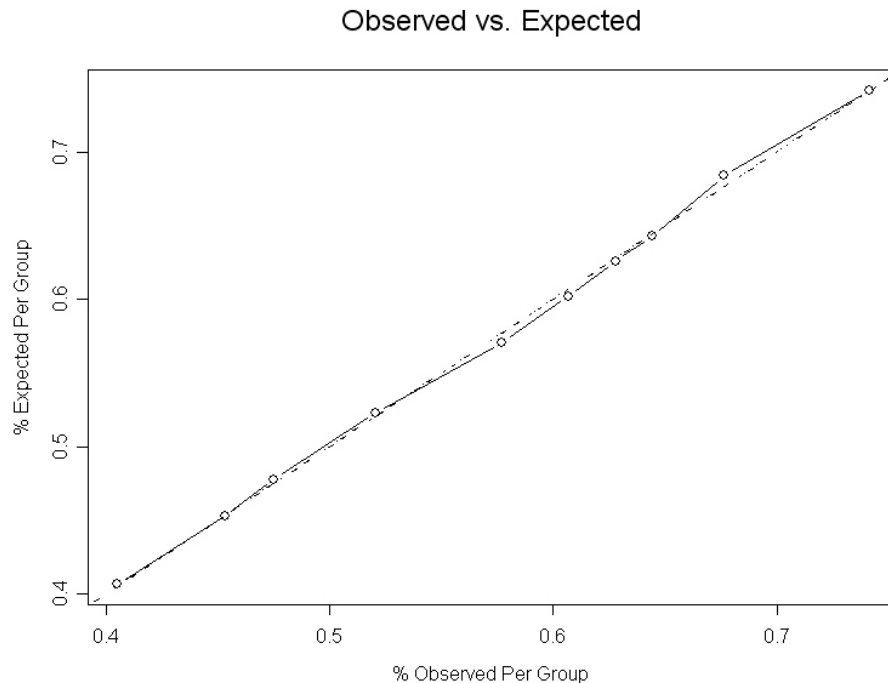


Figure 4.1. Comparison of Observed and Predicted Rates for Retention to the Grade of O-4 Model

Plots of influence statistics ΔB versus observations and change in deviance versus predicted probability of retention are included in Appendix B. Hamilton suggests that observations with influence statistics values greater than or equal to 1 are considered to be influential (Hamilton, 1992, p. 240). Figure B.1 suggests that all the observations have low influence statistic values. Figure B.2 shows the poorness-of-fit statistics versus predicted probabilities. Hamilton suggests a range between 0 and 7 for poorness-of-fit statistics value in logistic regression (Hamilton, 1992, p. 239). All the observations in the model have poorness-of-fit statistic values less than 3.5 and there is no particular observation that stands out as being poorly fitted.

As a last step for evaluation, Wald statistics values were analyzed. Without considering the effect of interactions, commissioning sources were all found statistically

significant even at the 99 percent confidence level. However, interactions between commissioning source and gender and between commissioning source and marital status suggested insignificance for some levels of commissioning source.

Table 4.2 presents a portion of Table A.1, which includes all the main effects and the interaction terms containing commissioning sources.

Table 4.2. Retention to the Grade of O-4 Model Regression Results

Coefficients	Value	Std.Error	t.value	Wald	95 % CI of Odds Ratio
(Intercept)	-0.33	0.19	-1.71	0.09	
MARITALSTAT.O32	0.19	0.06	3.25	0.00	
MARITALSTAT.O33	-0.27	0.22	-1.20	0.23	
NUMDEPEND.O32	-0.09	0.05	-2.07	0.04	0.83 – 1.00
NUMDEPEND.O33	0.00	0.05	0.06	0.95	0.91- 1.11
NUMDEPEND.O34	0.01	0.06	0.20	0.84	0.90 - 1.14
NUMDEPEND.O35	-0.18	0.08	-2.13	0.03	0.71 - 0.99
DPOG1	0.06	0.04	1.60	0.11	0.99 – 1.14
DPOG2	0.12	0.06	1.89	0.06	1.00 – 1.27
DPOG3	-0.02	0.05	-0.36	0.72	0.90 – 1.08
DPOG4	0.01	0.06	0.25	0.80	0.90 – 1.14
DPOG5	0.11	0.06	1.81	0.07	0.99 – 1.26
DPOG6	0.05	0.06	0.75	0.45	0.93 – 1.18
AGE	-0.01	0.01	-0.76	0.45	
RACE1	0.21	0.06	3.38	0.00	
RACE2	0.26	0.07	3.57	0.00	
RACE3	0.21	0.10	2.23	0.03	
COMMSOURCE2	0.50	0.05	10.88	0.00	
COMMSOURCE3	0.65	0.15	4.45	0.00	
COMMSOURCE4	0.29	0.11	2.63	0.01	
GENDER	-0.90	0.32	-2.81	0.00	
PE	-0.40	0.27	-1.52	0.13	
COMMSOURCE2GENDER	-0.25	0.10	-2.49	0.01	
COMMSOURCE3GENDER	0.21	0.23	0.91	0.36	
COMMSOURCE4GENDER	0.09	0.14	0.68	0.50	
MARITALSTAT.O32COMMSOURCE2	0.13	0.06	2.26	0.02	
MARITALSTAT.O33COMMSOURCE2	0.64	0.24	2.61	0.01	
MARITALSTAT.O32COMMSOURCE3	0.27	0.16	1.69	0.09	
MARITALSTAT.O33COMMSOURCE3	0.49	0.38	1.29	0.20	
MARITALSTAT.O32COMMSOURCE4	0.28	0.12	2.40	0.02	
MARITALSTAT.O33COMMSOURCE4	0.37	0.31	1.21	0.23	

Confidence intervals for odds ratios are only calculated for two of the explanatory variables that do not appear in interactions (NUMBER OF DEPENDENTS and DPOG). All the confidence intervals include 1, which indicate that there is not a significant difference in the predicted retention probabilities for the officers who have different numbers of dependents and who are in different Occupation Groups.

Figure 4.2 graphs the plot of predicted retention probabilities versus commissioning sources. The model suggests that OCS graduates are more likely to stay in the Army than those from other sources. Academy graduates have lower predicted retention probabilities than those from other commissioning sources.

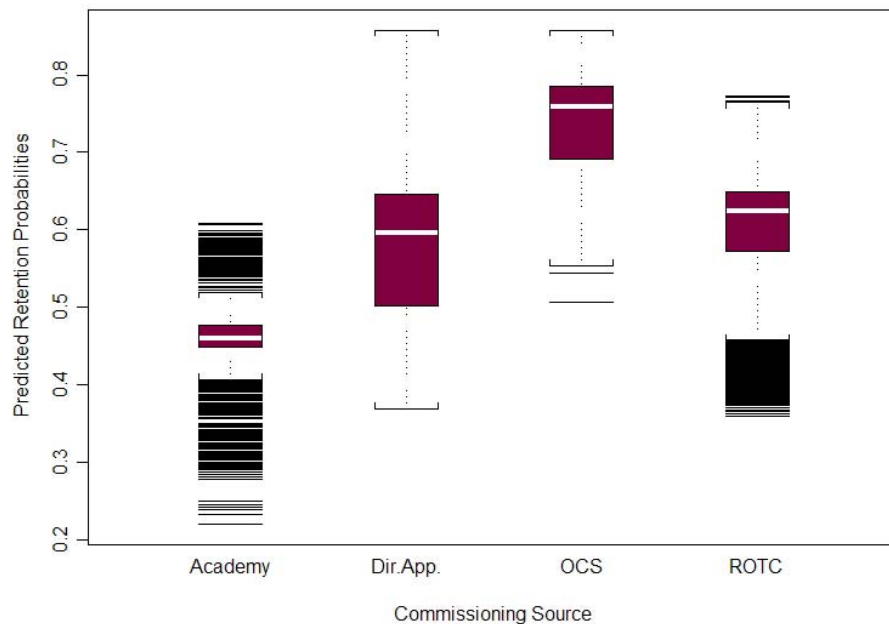


Figure 4.2. Predicted Retention Probabilities versus Commissioning Sources for the Retention to the Grade of O-4 Model

Since the results presented in Table 4.2 include interaction between commissioning source and gender, and between commissioning source and marital status, a correct interpretation should consider the effect of commissioning source for each gender category and for each marital status category separately. In order to analyze the effect of commissioning sources on retention among two gender groups (Male and Female), eight observations with different genders and commissioning sources were

created. These observations have the same features in terms of the other independent variables used in the model (Married, 2 dependents, White, 23.5 years old, DPOG = 1, Not Prior Enlisted). Figure 4.3 shows the predicted retention probability in each gender and commissioning source group.

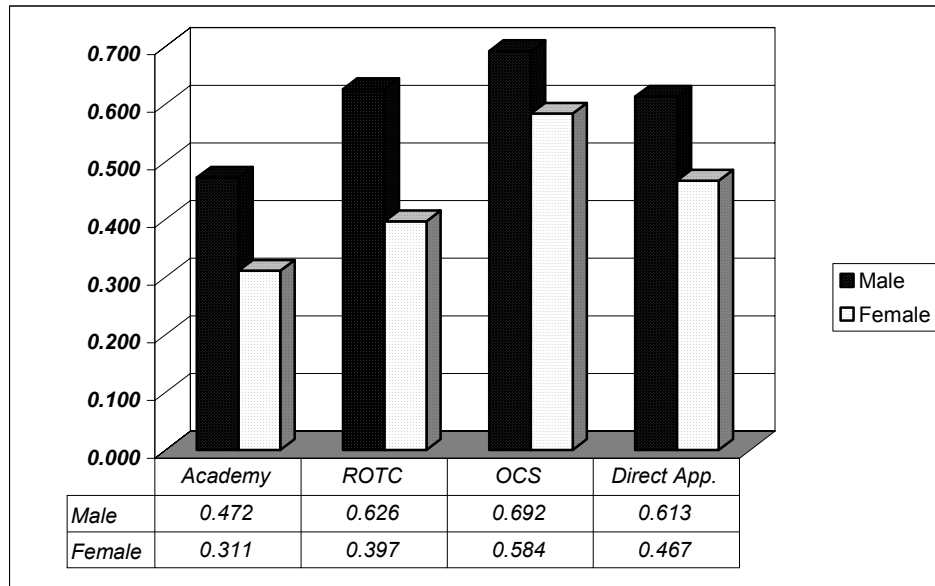


Figure 4.3. Effects of Commissioning Source and Gender on O-4 Retention Probability

In both gender groups, Academy graduates have the lowest predicted retention probabilities, while OCS graduates have the highest predicted retention probabilities. Male officers have higher predicted retention probabilities than female officers. A male OCS graduate with the traits given above has a 22 percent higher predicted retention probability than a male Academy graduate with the same traits. While the male ROTC graduate has a slightly higher predicted retention probability than the male Direct Appointment, the female Direct Appointment is predicted to be more likely to be retained than the female ROTC graduate.

Following the same approach, 12 male observations with different commissioning sources and marital statuses were created. Figure 4.4 graphs the predicted retention probabilities for officers with different commissioning sources and marital statuses. Academy graduates in all three marital status groups have the lowest predicted retention

probabilities, while OCS graduates have the highest predicted retention probabilities. ROTC graduates have higher predicted retention probabilities than Direct Appointments. Married officers seem to have higher retention rates than single officers in each commissioning group. In all commissioning source groups except the Academy, married or no longer married officers are more likely to be retained than single officers. A single Academy graduate has a higher predicted retention probability than one no longer married.

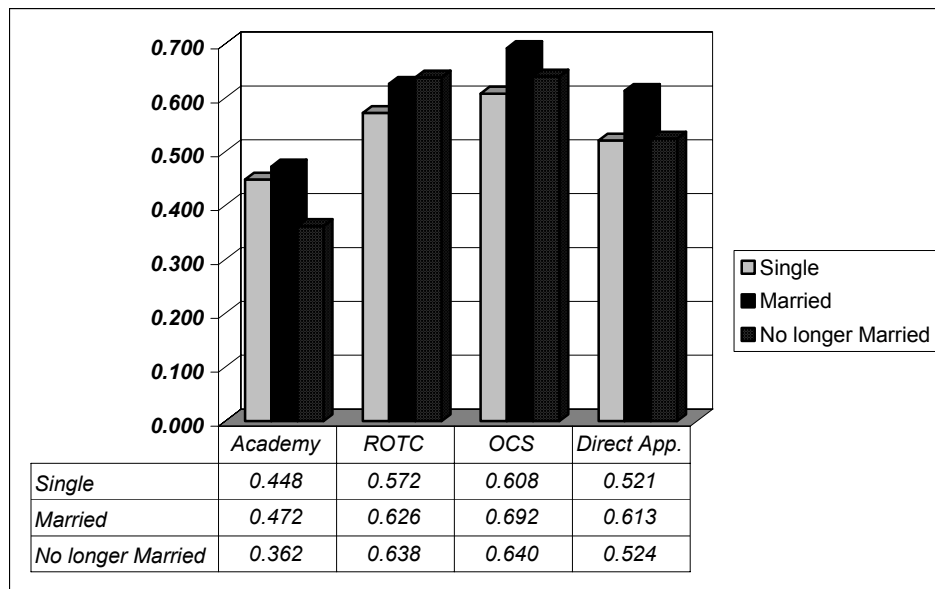


Figure 4.4. Effects of Commissioning Source and Marital Status on O-4 Retention Probability of Male Officers

In order to ascertain the effect of commissioning source and marital status on the retention of female officers, 12 female observations were created. Figure 4.5 graphs the predicted retention probabilities for the 12 female officers. Academy graduates in all three marital status groups have the lowest predicted retention probabilities, while OCS graduates have the highest predicted retention probabilities. Direct Appointments have higher predicted retention probabilities than ROTC graduates except the direct appointment that is no longer married. Single officers seem to have higher retention rates than married and no longer married officers in each commissioning group.

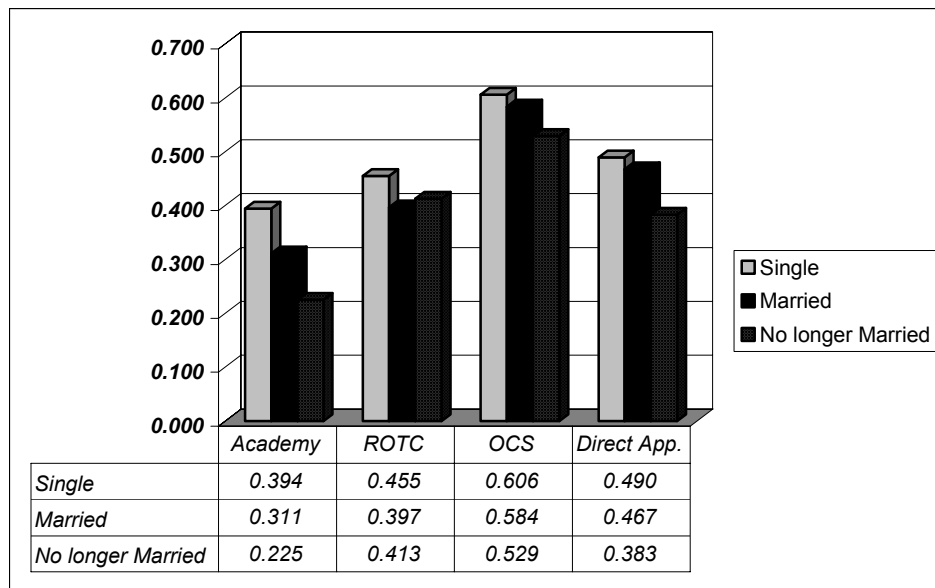


Figure 4.5. Effects of Commissioning Source and Marital Status on O-4 Retention Probability of Female Officers

The results of the logistic regression indicate a relationship between commissioning source and retention for the U.S. Army officers. Academy graduates are predicted to be less likely to be retained than graduates from other sources. The predicted retention probabilities for OCS graduates are higher than those from other sources. While male ROTC graduates are more likely to be retained than male Direct Appointments, female Direct Appointments are more likely to be retained than female ROTC graduates. Male officers are found to have higher retention probabilities than female officers and among the male officers, who constitute 85 percent of the data set, married officers are found to have higher retention probabilities than single and no longer married officers. Among female officers, being single seems to increase the probability of retention.

C. PROMOTION TO THE GRADE OF O-4 MODEL

Promotion to the grade of O-4 model analyzes 25,740 officers commissioned between 1981 and 1989. The model suggested by stepwise logistic regression is included in Appendix B.

The classification table for the promotion to the grade of O-4 is presented in Table 4.3. Officers with predicted promotion probabilities greater than 0.5 were predicted as

promoted to Major. Table 4.3 shows that the misclassification rate of predictions is 41 percent. The naïve misclassification error rate is 43 percent, which is 2 percent greater than the prediction misclassification rate. Although the prediction misclassification rate is lower than the naïve misclassification error rate, it is still quite high, possibly for two reasons. The first reason might be the lack of explanatory variables such as evaluation reports or Officer Basic School rankings, which might affect promotions. The second reason might be the difficulty of predicting retention, which directly affects promotions.

Table 4.3. Promotion to the Grade of O-4 Model Classification Table

OBSERVED VALUES	PREDICTION VALUES	
	FALSE	TRUE
0	11663	2861
1	7768	3448
Naïve Misclassification Rate	$11216/25740 = 0.436$	
Prediction Misclassification Rate	$(2861+7768) / 25740 = 0.412$	

Hosmer-Lemeshow test results are presented in Table B.1. The null hypothesis that states that the model fits well cannot be rejected at the 72 percent confidence level. Figure 4.6 shows the comparison of the expected percentages of promoted officers versus observed percentages of promoted officers in each of 10 groups.

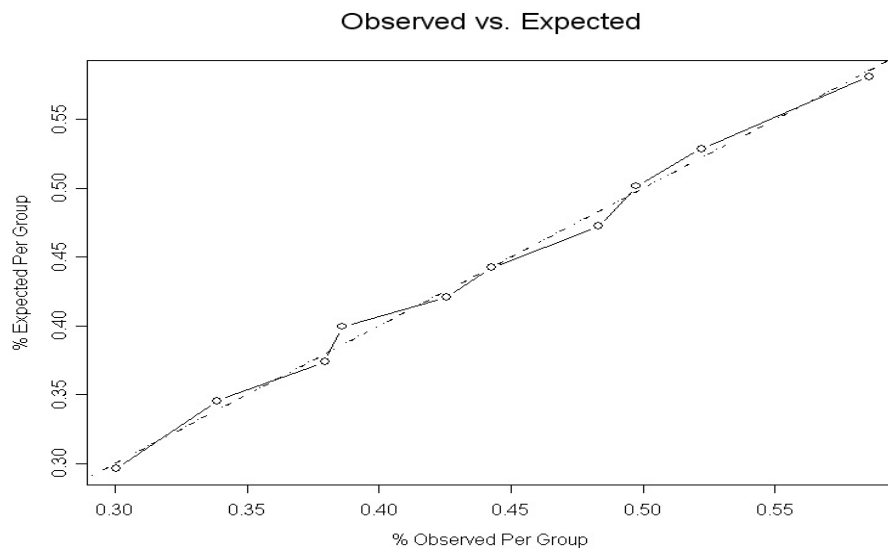


Figure 4.6. Comparison of Observed and Predicted Rates for Promotion to the Grade of O-4 Model

Plots of influence statistics ΔB versus observations and deviance versus predicted probability are included in Appendix B. Figure B.1 graphs the influence statistic values for the observations in the data set. One observation with a ΔB value greater than 1 was detected. Figure B.3 graphs the change in deviance versus predicted promotion probability. Five observations with the highest change in deviance values were considered as the worst fitted observations. The model was updated by removing one influential observation and five worst-fitted observations. Figures B.2 and B.4 reflect the changes in the diagnostic plots.

Logistic regression results for the updated promotion to the grade of O-4 model are presented in Table B.1. A portion of Table B.1 including all main effects and interaction terms that include commissioning sources is presented in Table 4.4. Without considering the effect of interactions, OCS is the only commissioning source found to be statistically significant.

Table 4.4. Promotion to the Grade of O-4 Model Regression Results

Coefficients	Value	Std.Error	t.value	Wald	95 % CI of Odds Ratio
(Intercept)	0.38	0.94	0.41	0.68	
MARITALSTAT.O32	0.46	0.14	3.23	0.00	
MARITALSTAT.O33	-0.10	0.43	-0.24	0.81	
NUMDEPEND.O32	-0.31	0.37	-0.82	0.41	
NUMDEPEND.O33	-0.06	0.40	-0.14	0.89	
NUMDEPEND.O34	-0.26	0.43	-0.59	0.55	
NUMDEPEND.O35	1.40	0.62	2.25	0.02	
DPOG1	1.02	0.53	1.93	0.05	
DPOG2	-1.33	0.79	-1.69	0.09	
DPOG3	-0.06	0.62	-0.10	0.92	
DPOG4	-0.70	0.58	-1.20	0.23	
DPOG5	-0.63	0.67	-0.94	0.35	
DPOG6	-0.30	0.80	-0.38	0.71	
RACE1	-0.38	0.86	-0.44	0.66	
RACE2	0.89	0.95	0.94	0.35	
RACE3	-0.38	1.17	-0.32	0.75	
COMMSOURCE2	-0.12	0.29	-0.41	0.68	
COMMSOURCE3	-2.90	1.39	-2.08	0.04	
COMMSOURCE4	-0.27	0.34	-0.79	0.43	
GENDER	-1.23	0.40	-3.05	0.00	
AGE	-0.04	0.04	-1.06	0.29	
PE	0.02	0.11	0.20	0.84	0.82 -1.27
COMMSOURCE2GENDER	-0.24	0.11	-2.14	0.03	

Coefficients	Value	Std.Error	t.value	Wald	95 % CI of Odds Ratio
COMMSOURCE3GENDER	-0.31	0.27	-1.19	0.23	
COMMSOURCE4GENDER	0.34	0.16	2.16	0.03	
RACE1COMMSOURCE2	0.42	0.29	1.47	0.14	
RACE2COMMSOURCE2	0.50	0.31	1.59	0.11	
RACE3COMMSOURCE2	0.29	0.34	0.85	0.40	
RACE1COMMSOURCE3	3.18	1.39	2.29	0.02	
RACE2COMMSOURCE3	3.67	1.41	2.60	0.01	
RACE3COMMSOURCE3	2.44	1.46	1.67	0.10	
RACE1COMMSOURCE4	0.07	0.33	0.20	0.84	
RACE2COMMSOURCE4	0.88	0.38	2.31	0.02	
RACE3COMMSOURCE4	0.46	0.48	0.96	0.34	
MARITALSTAT.O32COMMSOURCE2	0.12	0.06	1.82	0.07	
MARITALSTAT.O33COMMSOURCE2	0.67	0.29	2.32	0.02	
MARITALSTAT.O32COMMSOURCE3	0.36	0.18	2.00	0.05	
MARITALSTAT.O33COMMSOURCE3	1.10	0.43	2.56	0.01	
MARITALSTAT.O32COMMSOURCE4	0.32	0.13	2.44	0.01	
MARITALSTAT.O33COMMSOURCE4	0.67	0.36	1.85	0.06	

Confidence intervals for odds ratios were only calculated for one explanatory variable that does not appear in any interactions (PE). Being prior enlisted does not seem to affect the promotion to Major because the confidence interval for the odds ratio includes 1. Figure 4.7 depicts a plot of predicted promotion probabilities versus commissioning sources. Figure 4.7 suggests lower promotion probabilities for Academy graduates than those from other sources. OCS graduates have higher predicted promotion to Major probabilities than those from other sources.

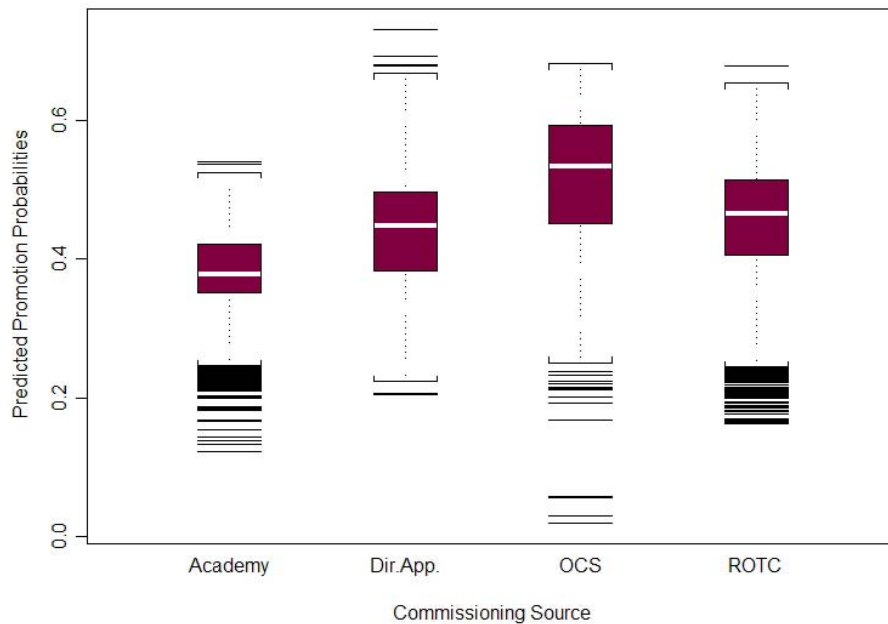


Figure 4.7. Predicted Promotion Probabilities versus Commissioning Sources for Promotion to the Grade of O-4 Model

The results of the logistic regression suggest interaction between commissioning source and gender, commissioning source and race and commissioning source and marital status. Similar to the approach followed in the retention model, predictions were calculated and compared separately to analyze the effect of commissioning sources on the promotion probabilities.

First, eight observations with different commissioning sources and genders were created. In terms of the other explanatory variables, the observations were assigned to either the most common category of the explanatory variable (Married, 2 dependents, White, DPOG = 1, Not Prior Enlisted) or the mean value for the explanatory variable (AGE=23.5). Figure 4.8 shows the promotion probabilities for males and females commissioned from four commissioning sources. While the OCS graduate has the highest predicted promotion probability among four male officers, the direct appointment has the highest predicted promotion probability among four female officers. Male officers have higher promotion probabilities than female officers. Academy graduates have lower promotion probabilities than graduates from other sources.

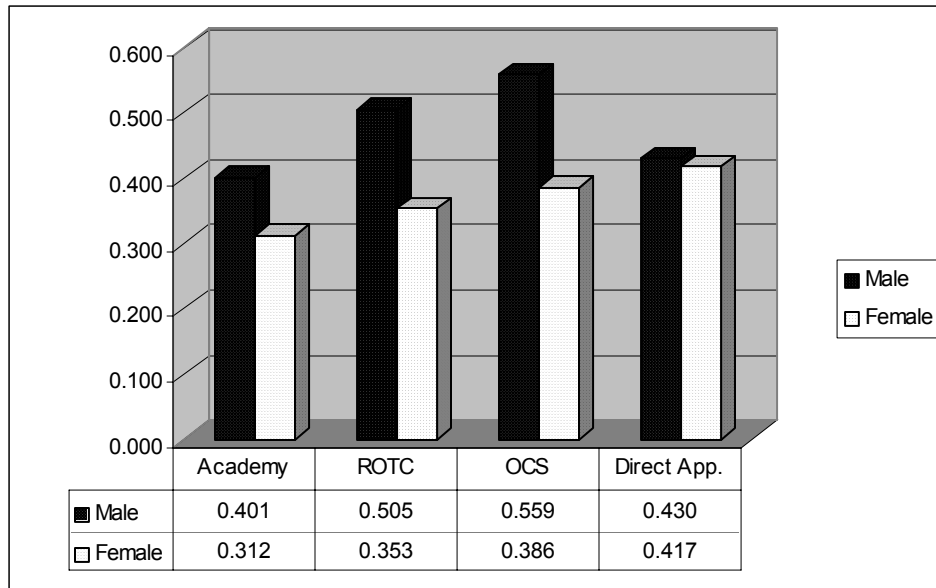


Figure 4.8. Effect of Commissioning Source and Gender on Promotion to the Grade of O-4 Probability

Figure 4.9 shows the promotion probabilities for the graduates from four commissioning sources with different marital statuses. Married officers have the highest predicted promotion probabilities in each commissioning source. Academy graduates have the lowest predicted promotion probabilities among the married and no longer married officers. Among the single officers, an officer with a Direct Appointment has the lowest predicted promotion probability. Single ROTC and OCS graduates have higher predicted promotion probabilities than that of Academy graduates. Among married and no longer married officers, OCS graduates have the highest promotion to Major probabilities, whereas among the single officers, ROTC graduates have the highest predicted promotion probability.

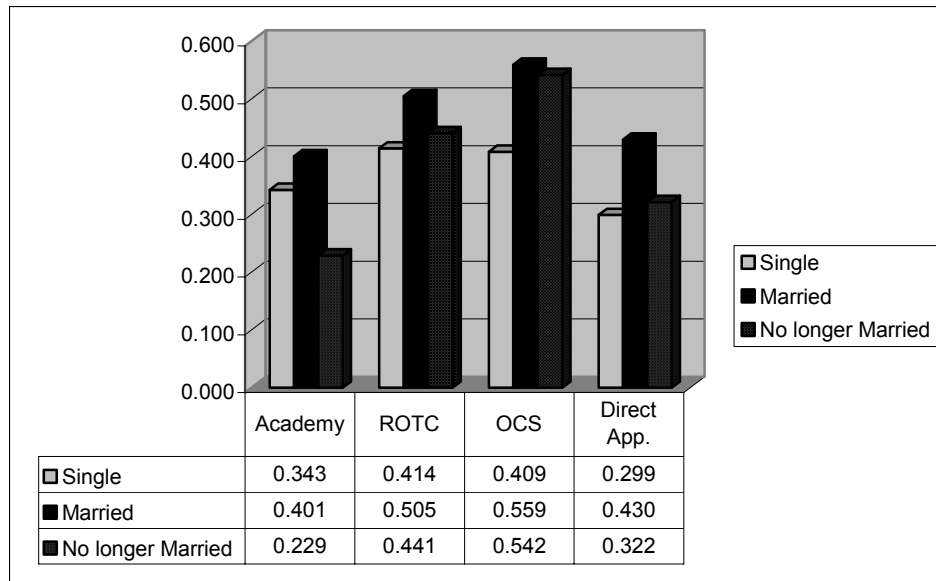


Figure 4.9. Effect of Commissioning Source and Marital Status on Promotion to the Grade of O-4 Probability

Figure 4.10 shows the promotion probabilities for the graduates from four commissioning sources with different races. Among the officers commissioned through ROTC and Academy, predicted promotion probabilities are the highest for white officers. Among the OCS graduates and Direct Appointments, black officers have the highest predicted promotion probabilities. Among white and black officers, who together make up 91 percent of the observations in the data set, OCS graduates have the highest promotion predicted promotion probabilities, whereas Academy graduates have the lowest predicted promotion probabilities. Among the officers who belong to other races, the OCS graduate has the lowest predicted promotion probability. In the same group, the Academy graduate has a lower predicted promotion probability than the officer commissioned through ROTC and Direct Appointment.

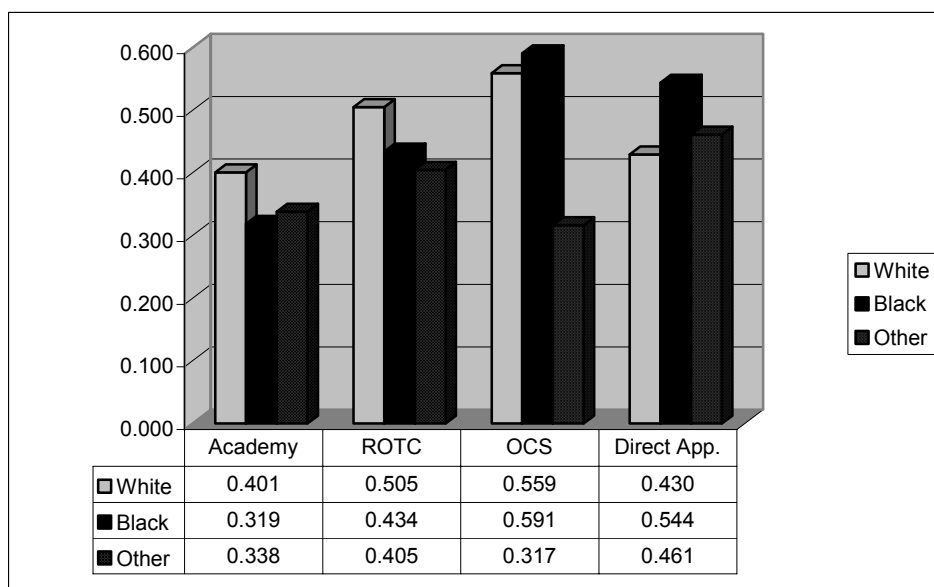


Figure 4.10 Effect of Commissioning Source and Race on Promotion to the Grade of O-4 Probability

The results for the model measuring promotion to the grade of Major indicate a relationship between commissioning source and promotion; however this effect is dependent on the race, marital status and gender of the officers. The results suggest that male and married officers are more likely to be promoted to Major. In terms of race, the results do not favor one race over the other. Most of the observations in the data set are male (85 percent) and white (82 percent), and among these officers, Academy graduates are less likely to be promoted to Major than those from other sources. In the same group, OCS graduates have the highest promotion probabilities and ROTC graduates have higher promotion probabilities than Direct Appointments.

D. PROMOTION TO THE GRADE OF O-5 MODEL

The model for promotion to the grade of O-5 analyzes the officers commissioned from 1981 to 1983. Multivariate analysis of the model started with analyzing the effects of the main effects on promotion to Lieutenant Colonel. Different than the retention model and the promotion to the grade of O-4 model, one-term deletions of the independent variables indicated GENDER to be insignificant at 65 percent confidence level. However, stepwise variable selection was performed without excluding GENDER. Logistic regression results and diagnostic plots are included in Appendix C.

In order to measure the predictive efficiency of the promotion model, a classification table was created. The threshold value for promotion predictions was taken as 0.5. The misclassification error rate for the predictions is 9 percent lower than the naïve misclassification error rate.

Table 4.5. Promotion to the Grade of O-5 Model Classification Table

OBSERVED VALUES	PREDICTION VALUES	
	FALSE	TRUE
0	1140	885
1	762	1424
Naïve Misclassification Rate	$2025/4211 = 0.481$	
Prediction Misclassification Rate	$(762+885) / 4211 = 0.391$	

The result of the Hosmer-Lemeshow test is shown in Table C.1. The p-value of 0.79 indicates that the null hypothesis, which states that the model fits well, cannot be rejected at a 79 percent confidence level. Comparison of the expected percentages of promoted officers versus observed percentages of promoted officers in each of 10 groups is shown in Figure 4.11. Figure 4.11 indicates that it is possible to use the model to predict probabilities of promotions to Lieutenant Colonel accurately.

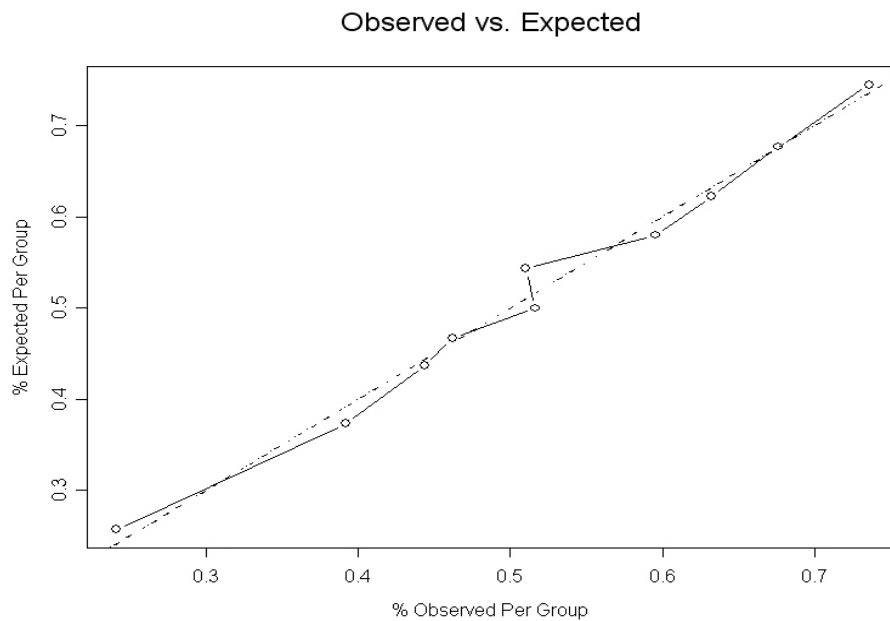


Figure 4.11. Comparison of Observed and Predicted Rates for Promotion to the Grade of O-5 Model

Plots of influence statistics ΔB versus observations and deviance versus predicted probability are included in Appendix C. Figure C.1 graphs the influence statistic values. All the observations have ΔB values less than 1, which indicate that there is not an observation exerting a considerable influence. Figure C.2 graphs the change in deviance versus predicted promotion probability. Although three observations seem to be to worst fitted among all the observations, they remained in the analysis because removing them caused poor goodness-of-fit statistics for the updated models.

Logistic regression results for the promotion to the grade of O-5 model are presented in Table C.1. The results include the main effects of all the explanatory variables except GENDER and DPOG. Table 4.6 presents a portion of Table C.1 including all main effects and interaction terms that include commissioning sources. All commissioning sources were found to be statistically significant at a 95 percent confidence level.

Table 4.6. Promotion to the Grade of O-5 Model Regression Results

Coefficients	Value	Std.Error	t.value	Wald	95 % CI of Odds Ratio
(Intercept)	4.29	1.23	3.49	0.00	
EDUCATION	0.64	0.07	9.09	0.00	1.65- 2.17
MARITALSTAT.O42	0.51	0.15	3.38	0.00	1.24- 2.24
MARITALSTAT.O43	-0.07	0.20	-0.35	0.73	0.64 - 1.37
NUMDEPEND.O42	-0.01	0.29	-0.04	0.97	
NUMDEPEND.O43	-0.73	0.28	-2.64	0.01	
NUMDEPEND.O44	-0.40	0.27	-1.47	0.14	
NUMDEPEND.O45	-0.21	0.30	-0.69	0.49	
AGE	-0.17	0.05	-3.17	0.00	
RACE1	-2.35	1.30	-1.81	0.07	
RACE2	-4.75	2.03	-2.34	0.02	
RACE3	-8.67	3.29	-2.64	0.01	
COMMSOURCE2	-0.39	0.08	-4.73	0.00	
COMMSOURCE4	-0.66	0.15	-4.56	0.00	
PE	-0.39	0.21	-1.86	0.06	
COMMSOURCE2PE	0.20	0.24	0.85	0.40	
COMMSOURCE4PE	-0.32	0.30	-1.09	0.28	

Confidence intervals for odds ratios are only calculated for two explanatory variables that do not appear in interactions (EDUCATION and MARITAL STATUS). The confidence interval of the odds ratios for EDUCATION is 1.65-2.17. Officers with

graduate education are found to have between 1.65 and 2.17 times greater predicted promotion probabilities than officers who do not have graduate education. Being married seems to increase the odds of promotion to Lieutenant Colonel by a factor between 1.24 and 2.24. The results suggest an effect of commissioning source on the promotion to the grade of O-5. A plot of predicted promotion probabilities versus commissioning sources is presented in Figure 4.12, and shows that Academy graduates are more likely to be promoted to Lieutenant Colonel than graduates from other sources. ROTC graduates seem to follow Academy graduates in terms of promotion probabilities to the grade of O-5. Direct Appointments have the lowest promotion probabilities among the commissioning sources.

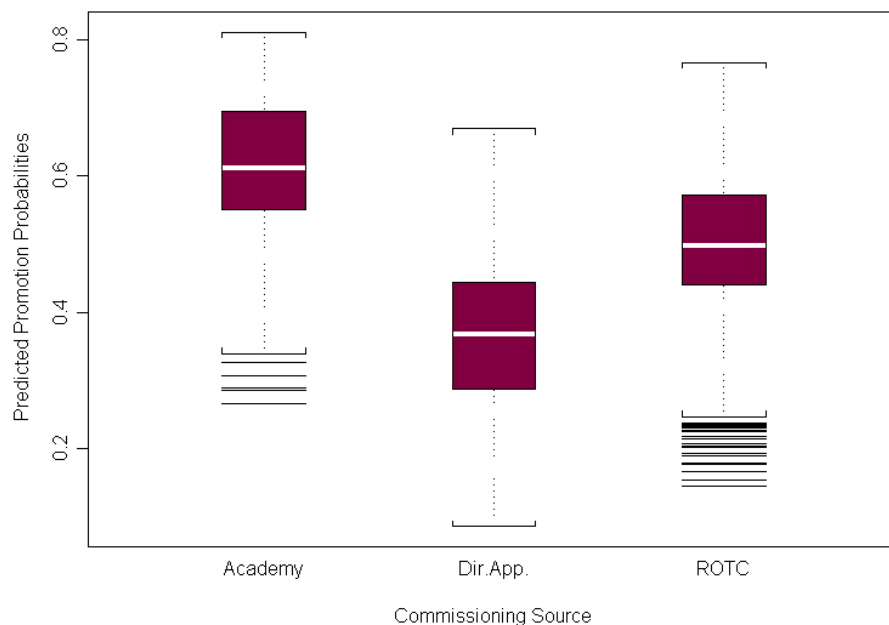


Figure 4.12. Predicted Promotion Probabilities versus Commissioning Sources for Promotion to the Grade of O-5 Model

The results of the logistic regression suggested an interaction between commissioning source and prior enlisted status. Following the approaches used in the retention and promotion to the grade of O-4 models, the effect of commissioning source was analyzed both for the prior enlisted officers and officers who are not prior enlisted.

Eight observations with the same features except commissioning source and prior enlisted status were created and predicted probability values were calculated. Figure 4.13 graphs the results of the predicted probabilities among each commissioning source.

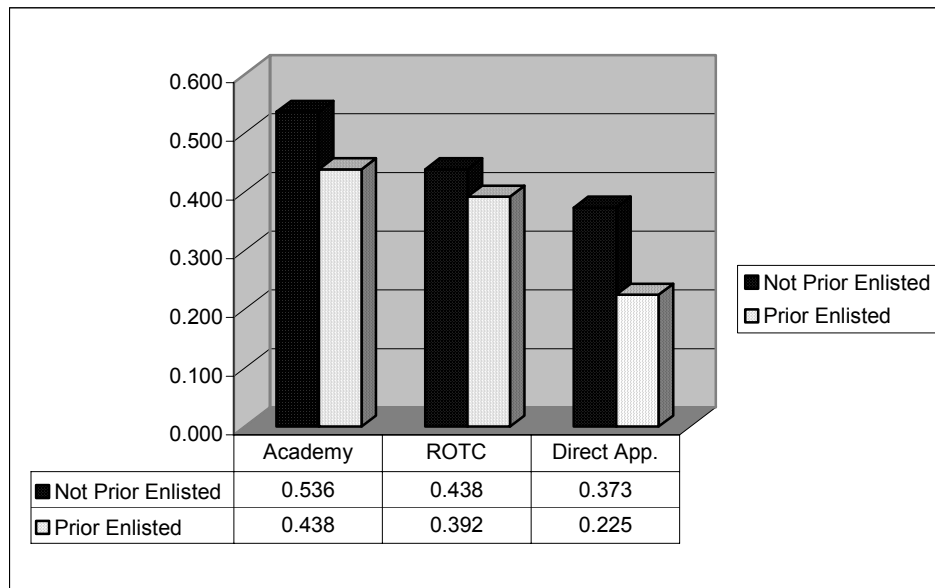


Figure 4.13 Effect of Commissioning Source and Prior Enlisted Status on Promotion to the Grade of O-5 Probability

Among the prior enlisted and non prior enlisted officers, Academy graduates have the highest promotion probabilities while Direct Appointments have the lowest promotion probabilities. Prior enlisted officers have lower promotion probabilities than officers who are not prior enlisted.

The results of promotion to the grade of O-5 model indicate that Academy graduates are more likely to be promoted to Lieutenant Colonel than Direct Appointments and ROTC graduates. Direct Appointments have lower promotion to the lieutenant colonel than officers commissioned through the Academy and ROTC. Being prior enlisted reduces the probability of promotion. Being married and having a graduate education seem to increase the probability of promotion to Lieutenant Colonel. Gender and DPOG do not seem to affect the promotion probabilities to Lieutenant Colonel.

E. CHAPTER SUMMARY

This chapter includes the multivariate data analysis for retention and promotion to the grade of O-4 and promotion to the grade of O-5 models. The chapter started by describing the steps followed through the multivariate analysis for the models developed in the study. Then, results of the multivariate analyses were presented separately for each model.

The results suggest that the commissioning source is a determinant of retention to the grade of O-4 and promotion to the grades of O-4 and O-5. Logistic regression results for retention to the grade of O-4 model indicate that the effect of commissioning source is different for officers with different marital statuses and genders. The findings suggest lower retention probabilities for officers who are commissioned through the U.S. Military Academy. Officers commissioned through OCS are found to have higher retention probabilities than those from other sources. Among the male officers and no longer married female officers, predicted retention to the grade of O-4 probabilities are found to be higher for ROTC graduates than for Direct Appointments, whereas among the single and married female officers, predicted retention to the grade of O-4 probabilities are found to be higher for Direct Appointments.

The results for promotion to the grade of O-4 model show that the effect of commissioning on promotion is dependent on the race, marital status and gender of the officers. Among male, white and married officers, who constitute the majority of the observations, predicted promotion probabilities are the lowest for the Academy graduates. In the same group, OCS graduates have the highest predicted promotion probabilities followed by the ROTC graduates and Direct Appointments.

In terms of the effects of commissioning sources, the findings for promotion to the grade of O-5 model contradict the results found for the retention and promotion to the grade of O-4 models. Academy graduates are found to have higher predicted probabilities of promotion to the grade of O-5 than those from other sources. ROTC graduates follow Academy graduates in terms of the predicted promotion probabilities to Lieutenant Colonel.

Male officers are found to have higher predicted retention and promotion to the grade of O-4 probabilities than female officers. Gender does not seem to affect the probability of promotion to Lieutenant Colonel. Married officers are found to have higher retention and promotion probabilities than single and no longer married officers. The findings for the promotion to Lieutenant Colonel indicate that having a graduate education and not being enlisted increase the probability of promotion. The next chapter presents the summary and conclusions of the study as well as future research recommendations.

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V. SUMMARY, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

A. SUMMARY AND CONCLUSIONS

The primary purpose of this thesis is to determine whether the source of commissioning affects the retention and promotion rates for U.S. Army officers. Chapter II discusses an overview of the pertinent literature and prior studies. Chapter III describes the data sets and the models used in the study, and presents the preliminary data analysis results. Chapter IV includes the logistic regression results for the models developed in the study.

Three different models are developed in the study: Retention to the Grade of O-4 model, Promotion to the Grade of O-4 model and Promotion to the Grade of O-5 model. The Retention to the Grade of O-4 model includes 32,054 officers commissioned between 1981 and 1991. Retention is defined as remaining in the Army to the 10th year of service, which corresponds to the primary selection point for promotions to Major. The model analyzes the relationship between retention and the explanatory variables, which refer to personal and military backgrounds of the U.S. Army officers. The results of logistic regression indicate that commissioning source is a significant determinant of retention to the grade of O-4. The findings suggest that Academy graduates are more likely to leave the Army before completing 10 years in the service than those from other sources. Officers commissioned through OCS are found to be more likely to stay in the Army than the officers commissioned through ROTC or Direct Appointment. Male officers have higher retention probabilities than female officers, and among the male officers, being married increases the probability of retention. Single female officers are found to be more likely to stay in the Army than married and no longer married female officers.

The analysis of Promotion to the Grade of O-4 Model includes 25,740 officers commissioned between 1981 and 1989. The results for promotion to the grade of O-4 model indicate a relationship between commissioning source and promotion. The effect of commissioning source is found to be different for each gender, race and marital status group. Among male, married and white officers, constituting the majority of the

observations in the data set, Academy graduates are found to be less likely to be promoted to Major than those from other sources. In the same group, predicted promotion probabilities are the highest for OCS graduates, followed by ROTC graduates and Direct Appointments sequentially. The results also suggest that being married and being male increases the probabilities of promotion. The results do not favor one race over another in terms of promotion to Major in the Army.

The Model for Promotion to the Grade of O-5 analyzes 4,211 officers commissioned between 1981 and 1983. The model does not include officers commissioned through OCS because only a few officers exist in the data set whose commissioning source is OCS. The findings of the model contradict the results found for the retention and promotion to the grade of O-4 Models. The results indicate that Academy graduates are more likely to be promoted to Lieutenant Colonel than ROTC graduates and Direct Appointments. Direct Appointments are found to have the lowest predicted promotion to Lieutenant Colonel probabilities. In terms of the effect of other variables, the findings indicate that having a Master's degree, being married and not being prior enlisted positively affect promotion to Lieutenant Colonel. Contrary to the retention and promotion to the grade of O-4 models, gender does not seem to affect promotion probabilities to Army Lieutenant Colonel.

In all three models used in the study, the commissioning source is found to be an important determinant of retention and promotion in the Army. Officers commissioned through the U.S. Military Academy are less likely to stay in the Army until the selections for promotion to Major, and less likely to be promoted to Major but more likely to be promoted to Lieutenant Colonel. Officers commissioned through OCS are more likely to be retained and promoted to Major than those from the other sources. Among male officers, ROTC graduates are found to be more likely to be retained and to be promoted to Major and Lieutenant Colonel than Direct Appointments. Among female officers, Direct Appointments are more likely to be retained and promoted to Major than ROTC graduates.

In terms of the effect of other explanatory variables, being married seems to have a positive effect on the retention and promotion to the grade of O-4 and promotion to the grade of O-5. Gender is found to be significant in the retention and promotion to the grade of O-4 models. However, it is insignificant in the promotion to the grade of O-5 model. Male officers are more likely to stay in the Army until the selection point for promotions to Major, and more likely to be promoted to Major than female officers. Still, a significant difference between for male and female officers in terms of promotion to Lieutenant Colonel probabilities does not exist. Being prior enlisted does not seem to affect the retention and promotion to the grade of O-4. However, it seems to have a negative effect on promotions to the grade of O-5. Education was only included in the promotion to the grade of O-5 model and possessing a Master's degree is found to have a positive effect on the promotion to Lieutenant Colonel. The DoD Primary Occupation Group and Number of Dependents are not found to have statistically significant effects on the retention and promotion probabilities of the U.S. Army officers.

B. LIMITATIONS AND RECOMMENDATIONS

The retention of the junior officers has become an important issue for the U.S. Army in recent years. In June 2000, at the direction of the U.S. Army Chief of Staff, the Army began the largest assessment ever conducted on training and leader development. The purpose of the research was to determine and assess the factors that impact the retention of junior officers. Data were collected from 13,500 leaders and spouses during interviews, surveys and focus groups. The research shows that the length of time as an officer, commissioning source, gender and mentoring are some of the factors affecting the decisions to leave the Army (Mitchell et al., 2000). Similar to the results found in this study, the survey results indicate that officers commissioned through the U.S. Military Academy are less likely to plan to stay than those commissioned in some other way. The researchers claim that this might be due to a disconnect between what the officers are taught in the Academy and what actually takes place in the field. Another reason the researchers propose for the low retention rates for Academy graduates is that officers with the highly selective military academy education may have more opportunities in the private sector. Findings of the research indicate that officers whose commissioning source is OCS are less likely to leave the Army than those who are commissioned

through the other commissioning sources. The researchers claim that officers who attend OCS would not have attended OCS if they were not intending to make a career in the Army. Male officers are found to be more likely to stay in the Army than female officers. Benefits satisfaction, the effectiveness of counseling received, and having a mentor are also found to be significant in determining the retention decisions of junior officers. (Mitchell et al., 2000).

The Retention model developed in this study focused on the retention of officers until the selection point for promotions to Major. Analyzing the retention of officers at different grades can help to understand the factors affecting retention better. Developing retention models at the grades of O-3, O-4 and O-5 separately and including the effects of time-dependent variables by using the values at each grade may produce more accurate results. One of the limitations of the data set was the lack of some of the explanatory variables such as officer evaluation reports and awards that are expected to affect the retention of officers. The inclusion of similar variables may also help produce more accurate results.

Promotion models in this study focused on the effect of commissioning sources on the promotion to Major and Lieutenant Colonel in the Army. The promotion results indicate that Academy graduates are less likely to be promoted to Major but more likely to be promoted to Lieutenant Colonel than those from other sources. Academy graduates were initially expected to have higher promotion rates at each grade because they are exposed to military acculturation more than the officers commissioned through other sources. Academy graduates who decide to stay in the Army and make a career in the Army can be assumed to be more likely to receive a promotion than those from other sources. One of the limitations of the data set for promotion to the grade of O-5 model is the lack of officers commissioned through OCS between 1981 and 1983. OCS graduates are found to be more likely to stay in the Army until the Major selection point and more likely to be promoted to Major. However, this study does not address their promotion probabilities to Lieutenant Colonel compared to the other sources.

The Army underwent a significant change with the introduction of career fields under the Officer Personnel Management System XXI. Officers assigned to one of the 16 branches at the beginning of their careers are assigned to one of the four career fields at the 10th year of service. A follow-on study can be done to ascertain the effect of commissioning sources and other factors on retention and promotion by developing models for each military branch or career field separately.

One of the major limitations for the promotion models in this study is the lack of explanatory variables such as success at the Basic Schools, Officer Evaluation Reports, physical fitness reports and awards in the data set. Inclusion of these variables in the promotion models may increase the accuracy of the promotion models. An alternative approach would be to follow Ergun's approach (2003) and to develop separate models for performance at the Officer Basic Schools and performance at different grades. A follow-on study can be done by developing the performance and promotion models separately and incorporating the results found in the models.

This study provides information about the effects of commissioning source and other personal and professional traits on the retention and promotion of U.S. Army officers. The results of this study can be used as a tool for forecasting retention and promotion trends in the U.S. Army. The U.S. Army Human Resources Command can use the results of the study in its efforts to adjust retention and promotion rates in accordance with the service needs.

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APPENDIX A. LOGISTIC REGRESSION RESULTS AND DIAGNOSTIC PLOTS FOR RETENTION TO THE GRADE OF O-4 MODEL

Table A.1. Logistic Regression Results for Retention to the Grade of O-4 Model

Coefficients	Value	Std.Error	t.value	Wald	95 % CI of Odds Ratio
(Intercept)	-0.33	0.19	-1.71	0.09	
MARITALSTAT.O32	0.19	0.06	3.25	0.00	
MARITALSTAT.O33	-0.27	0.22	-1.20	0.23	
NUMDEPEND.O32	-0.09	0.05	-2.07	0.04	0.83 – 1.00
NUMDEPEND.O33	0.00	0.05	0.06	0.95	0.91 - 1.11
NUMDEPEND.O34	0.01	0.06	0.20	0.84	0.90 - 1.14
NUMDEPEND.O35	-0.18	0.08	-2.13	0.03	0.71 - 0.99
DPOG1	0.06	0.04	1.60	0.11	0.99 – 1.14
DPOG2	0.12	0.06	1.89	0.06	1.00 – 1.27
DPOG3	-0.02	0.05	-0.36	0.72	0.90 – 1.08
DPOG4	0.01	0.06	0.25	0.80	0.90 – 1.14
DPOG5	0.11	0.06	1.81	0.07	0.99 – 1.26
DPOG6	0.05	0.06	0.75	0.45	0.93 – 1.18
AGE	-0.01	0.01	-0.76	0.45	
RACE1	0.21	0.06	3.38	0.00	
RACE2	0.26	0.07	3.57	0.00	
RACE3	0.21	0.10	2.23	0.03	
COMMSOURCE2	0.50	0.05	10.88	0.00	
COMMSOURCE3	0.65	0.15	4.45	0.00	
COMMSOURCE4	0.29	0.11	2.63	0.01	
GENDER	-0.90	0.32	-2.81	0.00	
PE	-0.40	0.27	-1.52	0.13	
MARITALSTAT.O32GENDER	-0.46	0.07	-6.30	0.00	
MARITALSTAT.O33GENDER	-0.45	0.17	-2.66	0.01	
RACE1GENDER	-0.26	0.15	-1.72	0.09	
RACE2GENDER	0.22	0.17	1.28	0.20	
RACE3GENDER	-0.16	0.24	-0.66	0.51	
COMMSOURCE2GENDER	-0.25	0.10	-2.49	0.01	
COMMSOURCE3GENDER	0.21	0.23	0.91	0.36	
COMMSOURCE4GENDER	0.09	0.14	0.68	0.50	
MARITALSTAT.O32COMMSOURCE2	0.13	0.06	2.26	0.02	
MARITALSTAT.O33COMMSOURCE2	0.64	0.24	2.61	0.01	
MARITALSTAT.O32COMMSOURCE3	0.27	0.16	1.69	0.09	
MARITALSTAT.O33COMMSOURCE3	0.49	0.38	1.29	0.20	
MARITALSTAT.O32COMMSOURCE4	0.28	0.12	2.40	0.02	
MARITALSTAT.O33COMMSOURCE4	0.37	0.31	1.21	0.23	
AGE: GENDER	0.04	0.01	3.13	0.00	
AGE: PE	0.02	0.01	2.30	0.02	
MARITALSTAT.O32PE	0.14	0.07	2.12	0.03	
MARITALSTAT.O33PE	0.09	0.17	0.53	0.60	
Hosmer- Lemeshow Goodness of fit test: Chi-squared = 2.0248, df = 8, p-value = 0.9802					

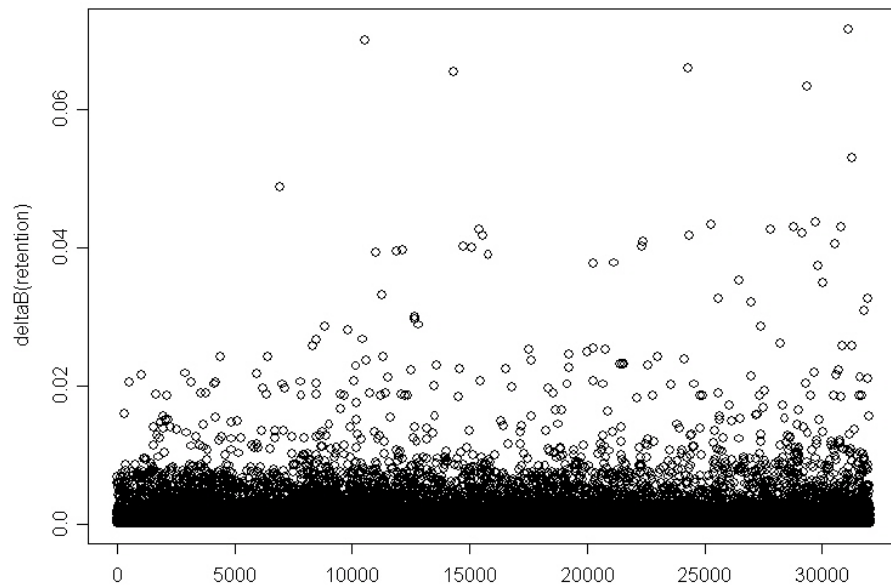


Figure A.1. Influence Statistics Plot for Retention to the Grade of O-4 Model

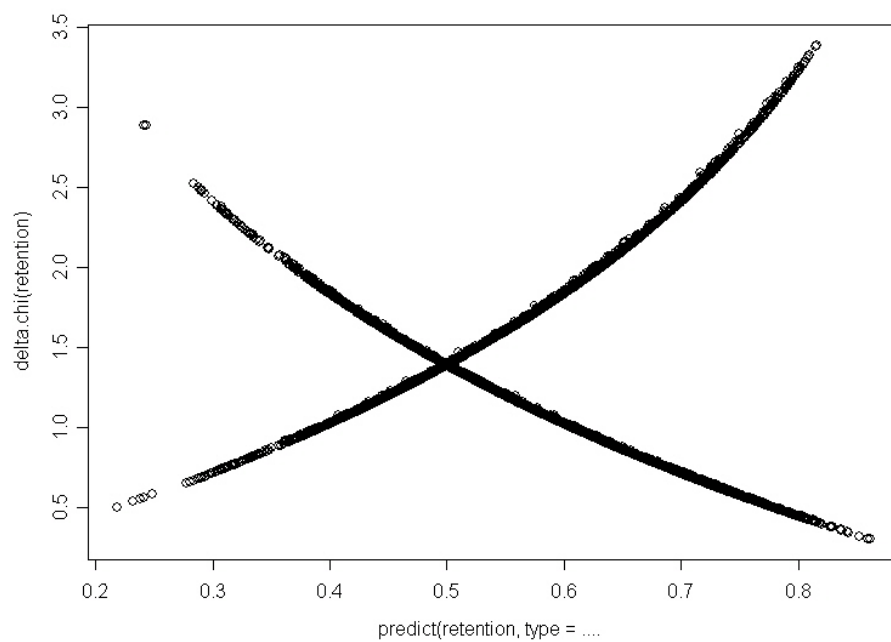


Figure A.2. Poorness-of-fit Statistics Plot for Retention to the Grade of O-4 Model

APPENDIX B. LOGISTIC REGRESSION RESULTS AND DIAGNOSTIC PLOTS FOR PROMOTION TO THE GRADE OF O-4 MODEL

Table B.1. Logistic Regression Results for Promotion to the Grade of O-4 Model

Coefficients	Value	Std.Error	t.value	Wald	95 % CI of Odds Ratio
(Intercept)	0.38	0.94	0.41	0.68	
MARITALSTAT.O32	0.46	0.14	3.23	0.00	
MARITALSTAT.O33	-0.10	0.43	-0.24	0.81	
NUMDEPEND.O32	-0.31	0.37	-0.82	0.41	
NUMDEPEND.O33	-0.06	0.40	-0.14	0.89	
NUMDEPEND.O34	-0.26	0.43	-0.59	0.55	
NUMDEPEND.O35	1.40	0.62	2.25	0.02	
DPOG1	1.02	0.53	1.93	0.05	
DPOG2	-1.33	0.79	-1.69	0.09	
DPOG3	-0.06	0.62	-0.10	0.92	
DPOG4	-0.70	0.58	-1.20	0.23	
DPOG5	-0.63	0.67	-0.94	0.35	
DPOG6	-0.30	0.80	-0.38	0.71	
RACE1	-0.38	0.86	-0.44	0.66	
RACE2	0.89	0.95	0.94	0.35	
RACE3	-0.38	1.17	-0.32	0.75	
COMMSOURCE2	-0.12	0.29	-0.41	0.68	
COMMSOURCE3	-2.90	1.39	-2.08	0.04	
COMMSOURCE4	-0.27	0.34	-0.79	0.43	
GENDER	-1.23	0.40	-3.05	0.00	
AGE	-0.04	0.04	-1.06	0.29	
PE	0.02	0.11	0.20	0.84	0.82 -1.27
GENDER:AGE	0.05	0.02	2.80	0.01	
MARITALSTAT.O32GENDER	-0.52	0.10	-5.02	0.00	
MARITALSTAT.O33GENDER	-0.34	0.20	-1.73	0.08	
COMMSOURCE2GENDER	-0.24	0.11	-2.14	0.03	
COMMSOURCE3GENDER	-0.31	0.27	-1.19	0.23	
COMMSOURCE4GENDER	0.34	0.16	2.16	0.03	
MARITALSTAT.O32RACE1	-0.07	0.12	-0.56	0.58	
MARITALSTAT.O33RACE1	-0.32	0.35	-0.91	0.36	
MARITALSTAT.O32RACE2	-0.43	0.15	-2.92	0.00	
MARITALSTAT.O33RACE2	-1.02	0.42	-2.42	0.02	
MARITALSTAT.O32RACE3	-0.27	0.21	-1.29	0.20	
MARITALSTAT.O33RACE3	-0.32	0.62	-0.51	0.61	
DPOG1AGE	-0.04	0.02	-1.64	0.10	
DPOG2AGE	0.07	0.03	1.93	0.05	
DPOG3AGE	0.01	0.03	0.23	0.82	
DPOG4AGE	0.04	0.02	1.61	0.11	
DPOG5AGE	0.04	0.03	1.45	0.15	

Coefficients	Value	Std.Error	t.value	Wald	95 % CI of Odds Ratio
DPOG6AGE	0.02	0.03	0.47	0.64	
NUMDEPEND.O32GENDER	0.23	0.11	2.04	0.04	
NUMDEPEND.O33GENDER	-0.26	0.16	-1.60	0.11	
NUMDEPEND.O34GENDER	0.37	0.23	1.62	0.10	
NUMDEPEND.O35GENDER	0.27	0.36	0.77	0.44	
RACE1COMMSOURCE2	0.42	0.29	1.47	0.14	
RACE2COMMSOURCE2	0.50	0.31	1.59	0.11	
RACE3COMMSOURCE2	0.29	0.34	0.85	0.40	
RACE1COMMSOURCE3	3.18	1.39	2.29	0.02	
RACE2COMMSOURCE3	3.67	1.41	2.60	0.01	
RACE3COMMSOURCE3	2.44	1.46	1.67	0.10	
RACE1COMMSOURCE4	0.07	0.33	0.20	0.84	
RACE2COMMSOURCE4	0.88	0.38	2.31	0.02	
RACE3COMMSOURCE4	0.46	0.48	0.96	0.34	
MARITALSTAT.O32COMMSOURCE2	0.12	0.06	1.82	0.07	
MARITALSTAT.O33COMMSOURCE2	0.67	0.29	2.32	0.02	
MARITALSTAT.O32COMMSOURCE3	0.36	0.18	2.00	0.05	
MARITALSTAT.O33COMMSOURCE3	1.10	0.43	2.56	0.01	
MARITALSTAT.O32COMMSOURCE4	0.32	0.13	2.44	0.01	
MARITALSTAT.O33COMMSOURCE4	0.67	0.36	1.85	0.06	
DPOG1PE	0.37	0.12	2.96	0.00	
DPOG2PE	0.06	0.19	0.34	0.74	
DPOG3PE	0.23	0.16	1.48	0.14	
DPOG4PE	0.16	0.16	1.03	0.30	
DPOG5PE	-0.02	0.17	-0.09	0.93	
DPOG6PE	0.27	0.19	1.40	0.16	
NUMDEPEND.O32AGE	0.01	0.02	0.45	0.65	
NUMDEPEND.O33AGE	0.00	0.02	-0.09	0.93	
NUMDEPEND.O34AGE	0.00	0.02	0.26	0.80	
NUMDEPEND.O35AGE	-0.07	0.02	-2.78	0.01	
RACE1AGE	0.01	0.04	0.25	0.80	
RACE2AGE	-0.04	0.04	-1.10	0.27	
RACE3AGE	0.01	0.05	0.12	0.90	
Hosmer- Lemeshow Goodness of fit test: Chi-squared = 5.2975, df = 8, p-value = 0.7254					

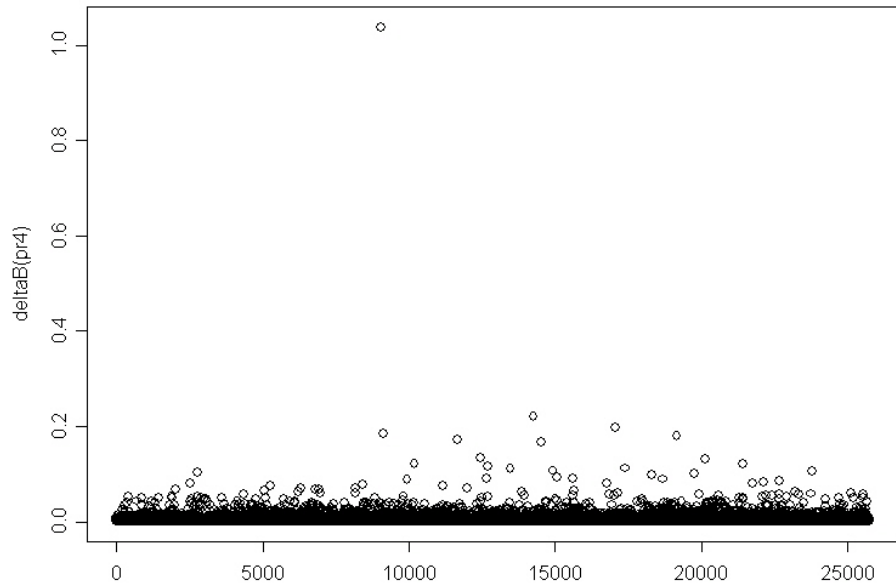


Figure B.1. Influence Statistics Plot for Promotion to the Grade of O-4 Model

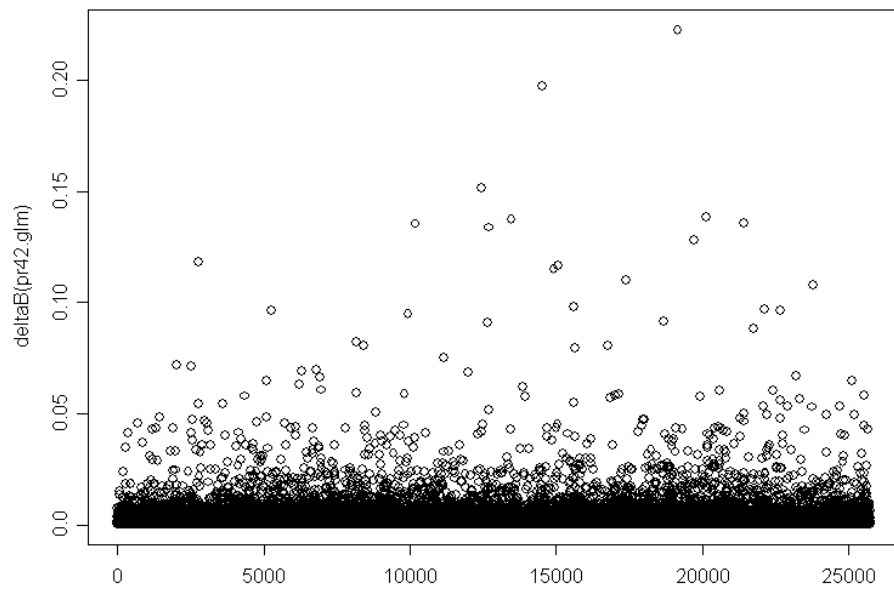


Figure B.2. Influence Statistics Plot for the Updated Promotion to the Grade of O-4 Model

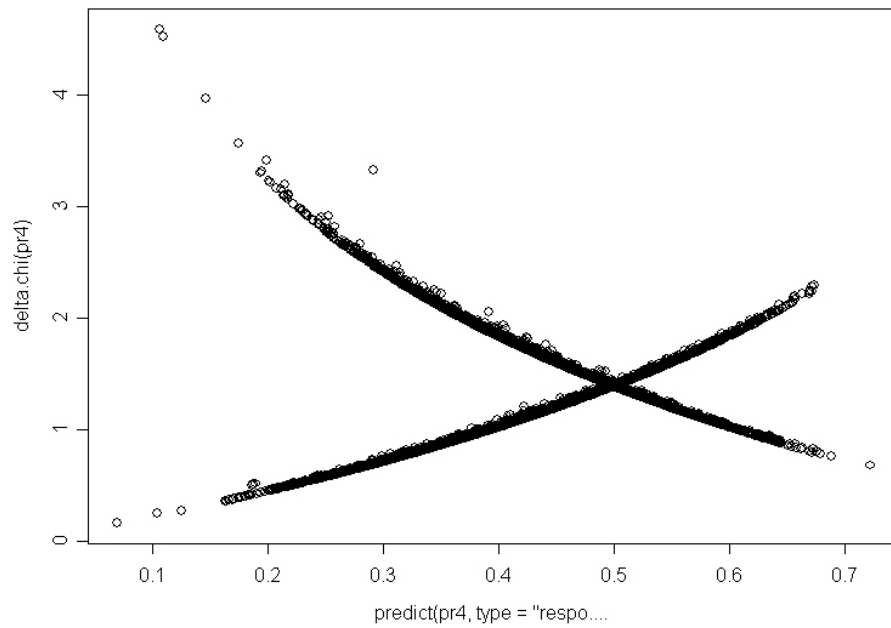


Figure B.3. Poorness-of-fit Statistic Plot for Promotion to the Grade of O-4 Model

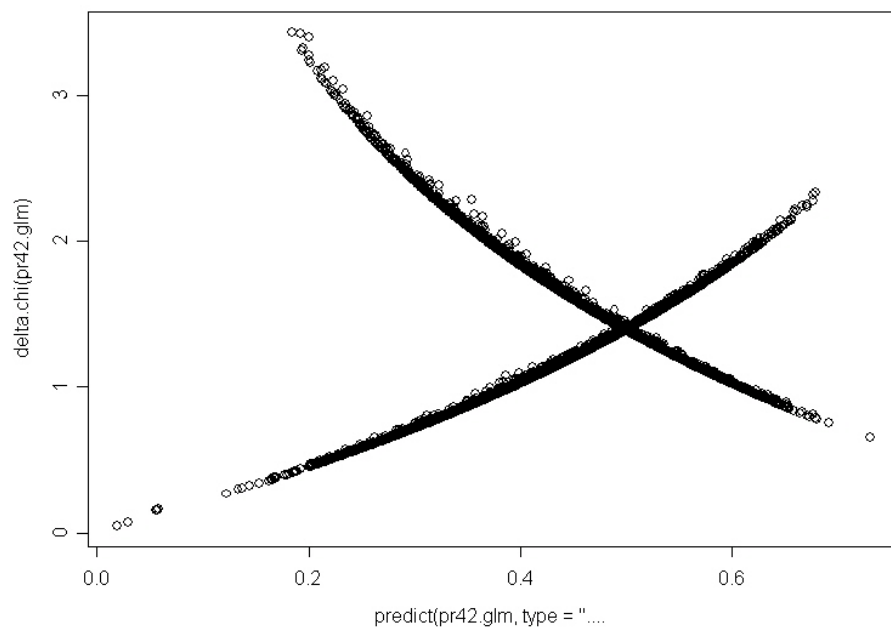


Figure B.4. Poorness-of-fit Statistic Plot for the Updated Promotion to the Grade of O-4 Model

APPENDIX C. LOGISTIC REGRESSION RESULTS AND DIAGNOSTIC PLOTS FOR PROMOTION TO THE GRADE OF O-5 MODEL

Table C.1. Logistic Regression Results for Promotion to the Grade of O-5 Model

Coefficients	Value	Std.Error	t.value	Wald	95 % CI of Odds Ratio
(Intercept)	4.29	1.23	3.49	0.00	
EDUCATION	0.64	0.07	9.09	0.00	1.65- 2.17
MARITALSTAT.O42	0.51	0.15	3.38	0.00	1.24- 2.24
MARITALSTAT.O43	-0.07	0.20	-0.35	0.73	0.64 - 1.37
NUMDEPEND.O42	-0.01	0.29	-0.04	0.97	
NUMDEPEND.O43	-0.73	0.28	-2.64	0.01	
NUMDEPEND.O44	-0.40	0.27	-1.47	0.14	
NUMDEPEND.O45	-0.21	0.30	-0.69	0.49	
AGE	-0.17	0.05	-3.17	0.00	
RACE1	-2.35	1.30	-1.81	0.07	
RACE2	-4.75	2.03	-2.34	0.02	
RACE3	-8.67	3.29	-2.64	0.01	
COMMSOURCE2	-0.39	0.08	-4.73	0.00	
COMMSOURCE4	-0.66	0.15	-4.56	0.00	
PE	-0.39	0.21	-1.86	0.06	
NUMDEPEND.O42RACE1	-0.13	0.30	-0.45	0.65	
NUMDEPEND.O43RACE1	0.62	0.29	2.18	0.03	
NUMDEPEND.O44RACE1	0.54	0.27	1.98	0.05	
NUMDEPEND.O45RACE1	0.14	0.31	0.46	0.65	
NUMDEPEND.O42RACE2	-0.80	0.52	-1.56	0.12	
NUMDEPEND.O43RACE2	-0.01	0.50	-0.01	0.99	
NUMDEPEND.O44RACE2	1.30	0.56	2.33	0.02	
NUMDEPEND.O45RACE2	-1.16	0.65	-1.79	0.07	
NUMDEPEND.O42RACE3	-0.03	0.80	-0.03	0.97	
NUMDEPEND.O43RACE3	1.43	0.95	1.50	0.13	
NUMDEPEND.O44RACE3	0.46	0.76	0.60	0.55	
NUMDEPEND.O45RACE3	-0.34	0.92	-0.37	0.71	
AGERACE1	0.07	0.06	1.34	0.18	
AGERACE2	0.19	0.09	2.22	0.03	
AGERACE3	0.35	0.14	2.51	0.01	
COMMSOURCE2PE	0.20	0.24	0.85	0.40	
COMMSOURCE4PE	-0.32	0.30	-1.09	0.28	
Hosmer- Lemeshow Goodness of fit test: Chi-squared = 4.623, df = 8, p-value = 0.797					

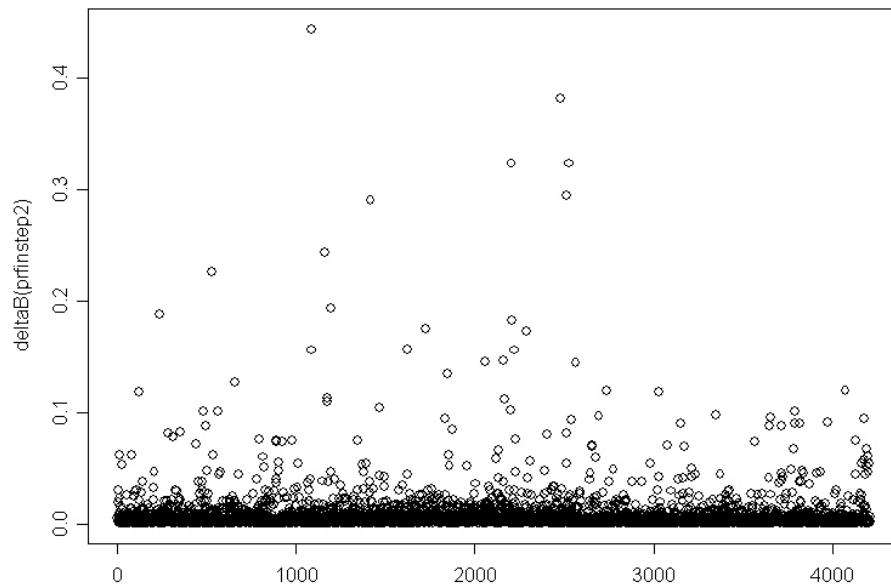


Figure C.1. Influence Statistics Plot for Promotion to the Grade of O-5 Model

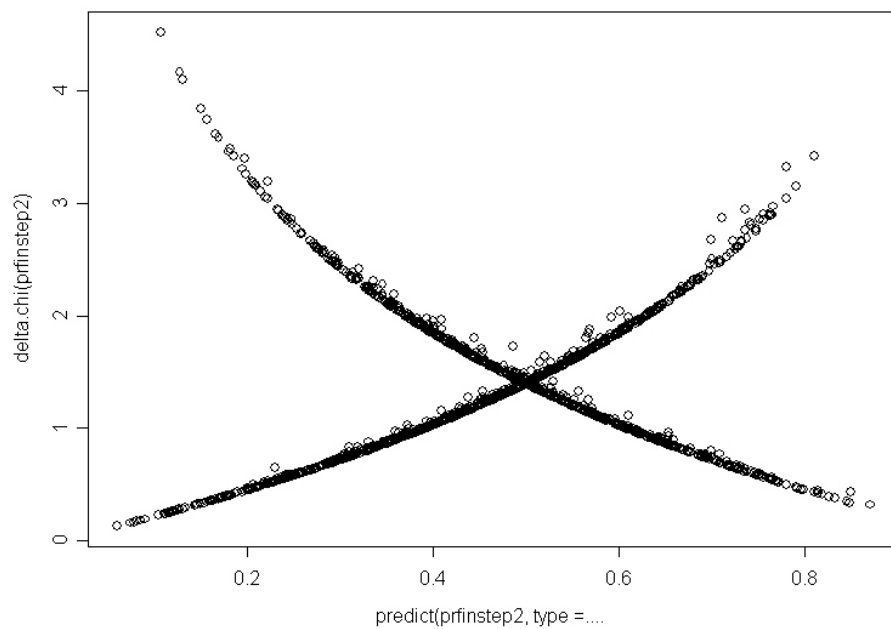


Figure C.2. Poorness-of-Fit Statistic Plot for Promotion to the Grade of O-5 Model

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